A PROPOSED REORGANIZATION OF TEST AND EVALUATION FOR NAVAL AIRCRAFT WEAPON SYSTEMS

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THESIS

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OF TEST AND EVALUATION
FOR NAVAL AIRCRAFT WEAPON SYSTEMS

by

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ABSTRACT

This thesis evaluates the Navy's test and evaluation (T&E) process for aircraft weapon systems, identifies problems, and proposes a reorganization of the Navy's T&E agencies. Many changes have been made to improve the T&E process, but some of these have resulted in costly inefficiencies. Contributing problems include: the Navy's "independent" test agency being tasked more on the basis of its apparent independence than on its testing expertise, lack of actual independence of the many test agencies, excessive testing duplication, inadequate testing expertise, lack of operational test objectives, inadequate test planning, lack of a weapon system T&E school, and numerous T&E management problems.

The establishment of a Naval T&E Command which is organizationally separate from the developing agency and the OPNAV program sponsor is proposed. The Naval T&E Command would be responsible for all T&E conducted by the Navy with the exception of that done by Navy Laboratories. The Naval T&E Command would have separate divisions responsible for development T&E and operational T&E, and the developing agency could task the T&E Command to perform any type of T&E.

TABLE OF CONTENTS

LIST OF FIGURES

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

AM	Acquisition Manager
ASN(R&D)	Assistant Secretary of the Navy for Research and Development
ASW	Anti-Submarine Warfare
BIS	Board of Inspection and Survey
CDT	Contractor Demonstration Tests
CNA	Center for Naval Analysis
CNM	Chief of Naval Material
CNO	Chief of Naval Operations
CNR	Chief of Naval Research
COMNAVAIRLANT	Commander, Naval Air Forces, Atlantic
COMNAVAIRPAC	Commander, Naval Air Forces, Pacific
COMOPTEVFOR	Commander, Operational Test and Evaluation Force
DCP	Development Concept Paper
DDR&E	Director of Defense Research and Engineering
DD(T&E)	Deputy Director of Defense Research and Engineering, Test and Evaluation
DMSO	Director, Major Staff Office
DOD	Department of Defense
DSARC	Defense Systems Acquisition Review Council
DT&E	Development Test and Evaluation
ECM	Electronic Counter Measures
FOT&E	Follow-On Operational Test and Evaluation
GAO	Government Accounting Office
IOT&E	Initial Operational Test and Evaluation

MDT	Mean Down Time
MTBM	Mean Time Between Maintenance
NADC	Naval Air Development Center, Warminster, Pennsylvania
NAPTC	Naval Air Propulsion Test Center, Trenton, New Jersey
NARF	Naval Aerospace Recovery Facility, El Centro, California
NATC	Naval Air Test Center, Patuxent River, Maryland
NATF	Naval Air Test Facility, Lakehurst, New Jersey
NAVAIR	Naval Air Systems Command
NAVAIRSYSCOM	Naval Air Systems Command
NAVMAT	Naval Material Command
NAVPRO	Navy Plant Representatives Office
NFO	Naval Flight Officer
NMC	Naval Material Command
NPE	Navy Preliminary Evaluation
NTE	Navy Technical Evaluation
NWC	Naval Weapons Center, China Lake, California
NWEF	Naval Weapons Evaluation Facility, Albuquerque, New Mexico
OEG	Operations Evaluation Group
OPEVAL	Operational Evaluation
OPNAV	Offices of the Chief of Naval Operations
OPTEVFOR	Operational Test and Evaluation Force
OSD	Offices of the Secretary of Defense
OT&E	Operational Test and Evaluation
PL	Public Law
PM	Program Manager

PMR	Pacific Missile Range, Pt. Mugu, California
R&D	Research and Development
RDT&E	Research, Development, Test and Evaluation
SAR	Selected Acquisition Report
SECDEF	Secretary of Defense
SECNAV	Secretary of the Navy
SOR	Specific Operation Requirement
TDP	Technical Development Plan
T&E	Test and Evaluation
TEMP	Test and Evaluation Master Plan
TPS	Test Pilot School
VX	Air Test and Evaluation Squadron
WST	Weapons Systems Test (a division of NATC)

ACKNOWLEDGEMENTS

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In this thesis comments are not identified with any particular interviewee and should only be taken as the author's interpretation of the consensus of opinions from certain agencies and not the opinion of any particular individual or agency. Any inaccuracies which might appear in this thesis are the sole responsibility of its author and stem either from a misinterpretation of the data or a lack of complete data in certain areas.

I. INTRODUCTION

A. GENERAL

During the past decade all phases of the Department of Defense (DOD) weapon system acquisition process have been under increasing criticism. Frequent cost growth, coupled with poor operational performance of many weapon systems when they entered operational service, has been the main impetus for the appointment of numerous committees and commissions to study the weapon system acquisition process. The President's Blue Ribbon Defense Panel, the Government Accounting Office, the Congress's Commission on Government Procurement, and the Armed Services Committees of the House of Representatives and Senate have consistently identified test and evaluation as a major problem area.

The current DOD major system acquisition policy prohibits the "total package procurement" concept that was in vogue in the 1960's. Concurrency between development and production is being minimized, and a determination of operational suitability, including logistic support requirements, is required before a production decision is made. This change in system acquisition philosophy has resulted in greater emphasis in test and evaluation. Consequently, problems existing in DOD's test and evaluation (T&E) process will have an even greater effect on the acquisition of major weapon systems than ever before.

It has been less than three years since the major change to the DOD weapon system acquisition process was implemented by DOD Directive 5000.1, entitled "Acquisition of Major Defense Systems" [Ref. 1]. Unfortunately, reforming the weapon system acquisition process is an undertaking which does not lend itself to instantaneous change. By now, most of the implementing DOD Directives and Navy instructions have been written, but changes in the area of test and evaluation are still being made and others comtemplated in order to more effectively implement the acquisition philosophy that is embodied in DOD Directive 5000.1. Many problems still exist in the Navy's T&E process, and new problems are being created by the implementation of the new DOD acquisition philosophy.

As a result of the criticism that has been directed at T&E, many people believe that improved and expanded test and evaluation will be the most significant step towards eliminating the cost growths and performance underruns that have been so typical of weapon system development programs. Problems do exist in the military's T&E process that adversely affect the weapon system acquisition process. However, many of the problems that exist in T&E are symptomatic of problems existing throughout the weapon system acquisition environment, i.e. Congress, DOD, and industry. In order to improve the weapon system acquisition process attention must be devoted to the entire acquisition process and not merely to making patchwork corrections to each

segment of the process [Ref. 2]. Although changes are required to the T&E process, one should not erroneously believe that these changes alone will have a significant effect in solving the many problems facing the weapon system acquisition process today.

B. PURPOSE

The purpose of this thesis is to:

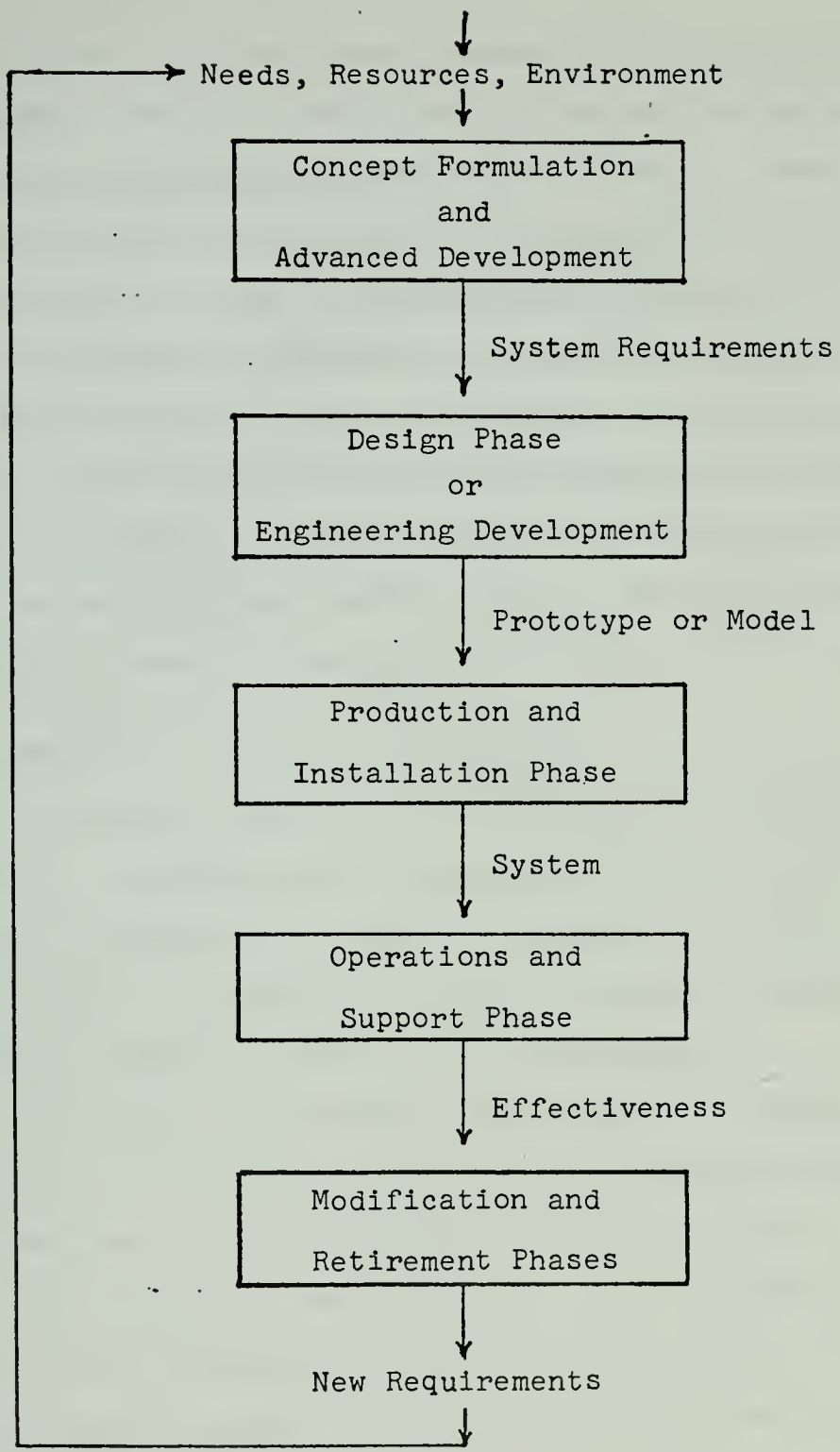
(1) evaluate the Navy's test and evaluation process for aircraft weapon systems,

(2) identify problems that exist in the Navy's current implementation of test and evaluation of aircraft weapon systems,

(3) propose a reorganization of the numerous agencies and activities that conduct test and evaluation of Navy aircraft weapon systems.

C. SCOPE

In the broadest sense test and evaluation (T&E) takes place throughout a system's life cycle (Fig. 1). In the Conceptual Phase test and evaluation takes the form of test planning and to a limited extent, simulation, breadboard, and laboratory testing. It isn't until the latter portions of the Design Phase that test and evaluation takes the more commonly thought of form of the testing of prototypes, models, and subsystems. It is during the Design Phase and the Production and Installation Phase that test and evaluation activity reaches a peak, and it is this T&E that will be the area of concern of this thesis. T&E does not terminate after the Production and Installation Phase, but continues until the system is retired. The T&E that occurs



System Life Cycle
[adapted from Ref. 3]

FIGURE 1

during the last two phases concentrates on determining optimal tactics to employ the system and testing and evaluating changes that are made to the system. These phases have minimal direct impact on the acquisition process and will not be an area of major consideration in this thesis.

Although many problems exist with the test and evaluation of Navy aircraft, ships, and weapons, this thesis deals solely with the Navy's test and evaluation of aircraft weapon systems.[1] Both the Navy and the contractor conduct T&E on each aircraft weapon system. This thesis will address primarily the T&E conducted by the Navy.

D. METHODS OF RESEARCH AND ANALYSIS

A thorough study of the available literature in the field of the management and organization of test and evaluation was conducted. This was followed by telephone interviews with key personnel directly involved with Naval aircraft weapon system test and evaluation.

The Annual Symposium of the Society of Experimental Test Pilots was attended. An entire major session was devoted to operational test and evaluation. This symposium afforded the opportunity to exchange ideas in the subject area with numerous key personnel involved in Navy, Air Force, Army, NASA, and contractor aircraft systems test and evaluation.

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[1]Aircraft weapon systems is used herein to refer to the total aircraft including the weapon delivery system and the weapon itself.

After completing this preliminary research effort, it became evident that a high degree of parochialism exists throughout the Navy's T&E community, with most people holding views that greatly favored the organization to which they were presently attached. Since the subject of deficiencies in the Navy's T&E organizations is a popular one, most people in each T&E activity shared similar ideas in the subject area. This is perhaps a result of the tremendous amount of dialogue and the large interchange of ideas that has taken place in this subject area.

Research was, therefore, confined to personal or telephone interviews with a limited number of personnel involved in each of the various phases of Navy T&E. Because of the parochialism that exists within each T&E organization, it was possible to obtain an accurate cross section of that organization's opinions of deficiencies in Navy T&E by interviewing only a few of its people.

Visits were made to the Offices of the Secretary of Defense, the Offices of the CNO, the Naval Air Systems Command Headquarters, the Naval Air Test Center, and the Headquarters of the Operational Test and Evaluation Force. Appendix A contains a tabulation of the specific organizations with which interviews were conducted.

Fifty-seven people were interviewed either in person or by telephone. Interviews varied in length from fifteen minutes to three and one-half hours, and telephone conversations varied in length from ten minutes to one and one-half hours.

II. BACKGROUND

A. WHAT IS TEST AND EVALUATION?

In order to ensure a common base for understanding the contents of this thesis, it is necessary to establish some fundamental definitions. A simple, yet all-inclusive, definition of test and evaluation which is utilized herein is the operation of a system or one or more of its components in a manner as similar as possible to its intended use and in an environment which approximates as closely as possible its operating environment for the purpose of gaining information to evaluate the performance of that system or component. The information obtained may be used to give a better understanding of the system's capabilities, to identify shortcomings, to develop improvements, to assist in designing the system's replacements or complements, to learn how to support and maintain the system, or for developing requirements for training personnel in the operation of the system.

Aircraft weapon system T&E can be divided into basically two types of testing: contractor T&E and military T&E. Contractor T&E is conducted by the contractor as a necessary step in his design and development of a weapon system and also as part of the contract requirements specified by DOD. Military T&E is that T&E conducted by military personnel to verify that the system meets the contract requirements and to ensure that the system being acquired is operationally suitable.

Aircraft weapon system T&E can also be divided into two different categories: Development Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E). Comprehensive definitions of DT&E and OT&E which are in concurrence with the most recent DOD Directives are given in Appendix B. Briefly, DT&E is that T&E conducted by both the contractor and the military under the auspices of the developing agency for the purpose of demonstrating that the engineering design and development are complete, demonstrating that the system will meet specifications, determining whether the design risks have been minimized with respect to system producibility, and estimating the system's military worth.

OT&E is that T&E conducted by the military to estimate a system's prospective military worth, operational effectiveness,[1] operational suitability (including compatibility, interoperability, reliability, maintainability, and logistic and training requirements), and the need for any design modifications. It is also used to determine optimum weapon system employment tactics and force structure. OT&E should be conducted by operational personnel with qualifications similar to those expected to ultimately operate the system, and the tests should be conducted in as realistic an operational environment as possible.

In summary, DT&E can be divided into two types: contractor conducted DT&E and military conducted DT&E.

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[1]Operational Effectiveness is a measure of how well a system meets its defined operational requirements in its intended operating environment.

OT&E can also be divided into two types: OT&E conducted to estimate a system's operational potential and OT&E conducted to determine how to best utilize the system. As a result of having received the most criticism, OT&E is currently the type of T&E that is being given major attention. The underlying thesis is that the validity of quantitative test data improves as realism (testing in an operational/combat environment) is added to the environment of the test program. The achievement of this objective depends upon one's interpretation of realism. It is easy to go overboard in the quest for realism to the extent of actually reducing the efficiency of the test program and adding needlessly to the cost of the test program. The current emphasis on OT&E appears motivated by an overzealous quest for the achievement of realism in the test environment.

B. TEST AND EVALUATION CRITICIZED

One of the earliest criticisms of T&E in DOD was made by the Military Aircraft Panel of the President's Scientific Advisory Committee (PSAC) in August of 1969. This panel recommended to the Secretary of Defense that an Operational Test and Evaluation (OT&E) organization be established in the office of the Secretary of Defense. It further went on to say that our lack of preparedness in previous wars could have been exposed if an adequate program for test and evaluation had existed [Ref. 4].

During this same time frame the Defense Science Board, the Joint Chiefs of Staff, the Bureau of the Budget, the

Comptroller General of the United States, and various Congressional Committees recognized that OT&E had been much less effective than necessary. Since OT&E is the fianl step in the research, development, test and evaluation (RDT&E) process, there appeared to be a potentially large pay-off for performing OT&E more effectively.

Perhaps, the most noteworthy of the T&E studies was conducted by the President's Blue Ribbon Defense Panel [Ref. 4]. Citing the aforementioned criticisms of T&E and specifically OT&E, one Task Group of the Blue Ribbon Defense Panel performed an assessment of how OT&E was being conducted. It is interesting to note that this study, which became a major driving force behind changes to the overall DOD T&E process, looked only at OT&E rather than the entire DOD T&E effort.

The main conclusions were:

(1) OT&E can and should be planned and executed much more effectively than it has been in recent years.

(2) OT&E results have not been made available to or used by DOD agencies which need them.

(3) There is a requirement for an OT&E organization at higher-than-service level.

(4) OT&E within the services is done most effectively when OT&E organizations report directly to the Chief of Service, representing both the developer and user, but organizationally independent of both.

(5) Inadequate funding has adversely affected the conduct of needed OT&E.

The panel went on to recommend:

(1) An operational T&E Group should be established with civilian leadership reporting directly to the Deputy Secretary of Defense.

(2) A Defense Test Agency should be established with broad authority and responsibility for DOD test activities giving particular emphasis to OT&E.

(3) The Secretary of Defense should communicate to the Military Departments the importance he assigns to OT&E and his conviction that OT&E is best served when independent OT&E organizations report directly to the Service Chiefs, Service Secretaries, or both.

The Navy fared best of all services in this study, since it had in existence an independent OT&E agency, its Operational Test and Evaluation Force (OPTEVFOR). Even though the Blue Ribbon Defense Panel demonstrated by many of its statements a misunderstanding of how the Navy conducted its T&E (see page 46), their recommendations received almost universal acceptance.

In 1971 the Government Accounting Office (GAO) responded to Congressional requests and conducted a study of T&E for major weapon systems [Ref. 5]. Its main conclusions were:

(1) The practices used in establishing test objectives were generally inadequate.

(2) Most weapon systems reviewed did not have adequate plans for testing.

(3) T&E for most weapon systems was not accomplished in a timely manner.

(4) Complete and valid T&E data was not available to decision-makers prior to key decision points in the acquisition cycle.

The GAO report recommended:

(1) Completion of appropriate testing and evaluation prior to key decision points in the acquisition cycle.

(2) Stringent controls over the granting of any waivers from required T&E.

(3) Preparation of succinct summary reports by the testing agency for all levels of management. Interested management levels may wish to comment on these summary reports, however, they should not be permitted to change the basic content.

The Commission on Government Procurement in 1972 echoed many of the previously cited criticisms [Ref. 2] of DOD T&E. Its emphasis was on the need to establish an operational test agency that is independent of the development and user organizations.

The main criticisms coming from these studies appear to have been the lack of adequate "operational" test and evaluation and the lack of testing "independent" of the weapon system developers. Consequently, the words "operational" and "independent" are now used in every directive or instruction that addresses T&E.

C. NEW HIGH LEVEL T&E POLICY

DOD Directive 5000.1 of July 13, 1971 established a new policy for the acquisition of major defense systems. In an attempt to correct deficiencies in DOD T&E cited in the previously discussed studies, DOD Directive 5000.1 states the following regarding T&E:

> "Test and evaluation shall commence as early as possible. A determination of operational suitability, including logistic support requirements, will be made prior to large-scale production commitments, making use of the most realistic test environment possible and the best representation of the future operational system available. The results of this operational testing will be evaluated and presented to the DSARC at the time of the production decision" [Ref. 1].

Memorandum issued by Deputy Secretary of Defense David Packard provided interim guidance to the services for implementing changes to their respective T&E systems until the issuance of a specific directive addressing T&E (Directive

5000.3 was issued in January 1972). This comprehensive directive [Ref. 6] covers all phases of DOD test and evaluation and is summarized as follows:

(1) Development test and evaluation is to be planned, conducted, and monitored by the developing agency of the DOD Components.[1]

(2) In each DOD Component there will be one major field agency separate and distinct from the developing/procuring command which will be responsible for operational test and evaluation and which will report results of its independent T&E directly to the Military Service Chief or Defense Agency Director.

(3) Operational testing should be separate from development testing; however, combined testing may be conducted where separation would cause delay involving unacceptable risk or unacceptable increased cost.

(4) At least an initial phase of operational test and evaluation (IOT&E) will be accomplished prior to the first major production decision sufficient to provide a valid estimate of expected system operational effectiveness and suitability.

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[1]DOD Component is a term referring to each of the main organizations that comprise the Department of Defense: Army, Navy, Air Force, and the Defense Supply Agency, for example.

(5) The Development Concept Paper (DCP) prepared for use at the time of the Program Initiation Decision for a major Defense System will identify the critical questions and areas of risk to be resolved by test and evaluation.

(6) When the DOD component proposes to initiate Full-Scale Development, it must present to the Defense Systems Acquisition Review Council (DSARC) the results of T&E accomplished to that date, an updated statement of critical questions and areas of risk still needing test to be resolved, and a detailed statement of test plans and milestones.

(7) Prior to the first major production decision DSARC will assess the adequacy of test results to support a production decision and the adequacy of plans and schedules for any remaining testing.

(8) The duties of the Deputy Director Defense Research and Engineering, Test and Evaluation (DD(T&E)) are delineated. He has across-the-board responsibility for the Office of the Secretary of Defense (OSD) in test and evaluation matters.

One of the strongest motivating forces behind the changes that have taken place in DOD's test and evaluation process has been Congress. The report of the Senate Armed Services Committee from the 1st session of the Ninety-Second Congress [Ref. 7] fully supported the findings of the Blue Ribbon Defense Panel. The Committee reiterated weaknesses in DOD's

operational test and evaluation — lack of testing independent of the weapon system developer, service opposition to independent operational test and evaluation, lack of funds and facilities, and lack of high-level attention and management. The committee went on to state that insufficient OT&E in the past had resulted in the production and deployment of some weapon systems which were too complex to be effective. The committee reasoned that the military was misled into thinking its personnel would be able to maintain the systems satisfactorily, but the level of technical ability required to do so often exceeded that possessed in sufficient quantity by the military. The committee reasoned that adequate OT&E would have revealed this soon enough to make appropriate changes.

In the same session of Congress, an amendment to the 1972 procurement authorization bill (Public Law 92-156) was passed [Ref. 8]. This amendment, Section 506, requires that additional cost, schedule, and performance data be reported to Congress in support of the annual budget request and periodically throughout the year before major system procurement awards are made [Ref. 9]. The required reports to Congress, called Congressional Data Sheets, must include data on OT&E results for each weapon system each year until procurement is completed. If OT&E has not been conducted, a statement of the reasons therefore and the results of such other T&E as has been conducted must be included in the report to Congress.

The Fiscal Year (FY) 73 budget request was accompanied by the newly required supporting program data reports. While similar supporting data were provided to Congress previously, PL 92-156 Section 506 standardized this procedure and made compliance mandatory. In passing this amendment, the intent of Congress appeared to be to provide a means of obtaining a broader range of data as a basis to make informed judgments on the merits of the programs and their funding requirements [Ref. 9]. However, these Congressional Data Sheets seem to be somewhat redundant of the information contained in the Selected Acquisition Reports (SAR's) which are also required by Congress with copies sent to GAO. The SAR's have often been late in submission. For this and other reasons SAR's have proven to be ineffective documents, but no current move is underway to abolish the SAR. Although Congress has not changed its methods of acting on the Armed Service Authorizations or Appropriations Bills since receiving the Congressional Data Sheets, there is confidence in the Congress and the GAO that improved communications on weapon system development is being created between the Congress and DOD.

III. NAVY IMPLEMENTATION OF T&E POLICY

A. GENERAL

As stated in Section IIB, the Navy was the only service which had in existence at the time of the Blue Ribbon Panel Study an independent operational test and evaluation agency. This was the Operational Test and Evaluation Force (OPTEVFOR), which reported to the Chief of Naval Operations (CNO). It was a relatively small organization of approximately 1400 officers and enlisted men and did not maintain its own test ranges or instrumentation.

It was obvious that the most expedient method to comply with the DOD directives would the expansion of the role of OPTEVFOR to do the required OT&E. Appendix C contains a list of the various instructions and directives that pertain to Navy Aircraft Weapon System test and evaluation. The basic content with regards to T&E of a few of these Navy originated instructions will be discussed in order to show the Navy's method of implementing the broad T&E guidelines given by Sec Def in DOD Directives 5000.1 and 5000.3.

B. SECNAV INSTRUCTION 5000.1 [Ref 10]

SECNAV Instruction 5000.1 is the Navy's implementing instruction of DOD Directive 5000.1. It assigns Commander Operational Test and Evaluation Force (COMOPTEVFOR) as the Navy's independent test agency for the required operational test and evaluation. The general sequence of test and

evaluation events under the new acquisition philosophy is given as follows:

"1. Laboratory/contractor preliminary T&E of bread-board of demonstration hardware during the conceptual effort.

2. Contractor/development activity T&E of subsystems and/or full-scale demonstrator hardware during full-scale development.

3. Technical T&E conducted by the contractor with Navy participation during pre-production/production.

4. IOT&E (Initial Operational Test and Evaluation) by or with the active participation of Navy operational forces prior to the major production decision.

5. Navy OPEVAL (Operational Evaluation) prior to approval for service use and inventory acceptance (except for ships).

6. Navy follow-on T&E.

7. Conduct of T&E by the Board of Inspection and Survey (BIS) and recommendation to CNO for service acceptability" [Ref. 10].

C. OPNAV INSTRUCTION 3960.8 [Ref. 11]

OPNAV Instruction 3960.8, issued by CNO, is essentially the basic implementing instruction of DOD Directive 5000.3. OPNAV Instruction 3960.8 establishes guidance and policy for T&E of all Navy weapon systems, subsystems, components, and support systems. Specific areas discussed in this instruction that are germane to this thesis are discussed below.

Development test and evaluation (DT&E) is defined as T&E conducted under the sponsorship of the developing agency which is undertaken to facilitate the evolution of a system. The primary objective of DT&E is given as the generation of essential and valid data upon which to base design decisions during the development process.

Operational test and evaluation is defined as including all T&E efforts undertaken for the purpose of obtaining operational information throughout the system's life cycle. This T&E is used to support both the acquisition process and the optimum employment of the system. OT&E is broken into two phases: IOT&E (Initial Operational T&E) and FOT&E (Follow-on Operational T&E).[1] IOT&E is defined as that T&E accomplished by or under the supervision of the Navy's independent testing agency (OPTEVFOR) prior to the first major production decision. FOT&E is the continuing T&E of a weapon system conducted under fleet conditions by operational personnel in order to verify system performance, validate correction of deficiencies previously identified, and refine tactical employment doctrines and requirements for personnel and training.

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[1]Follow-on Operational Test and Evaluation (FOT&E) is defined in OPNAV Instruction 3960.8 to include all OT&E following IOT&E. The useage of the term FOT&E has been rather limited and is not used in OPNAV Instruction 5440.47D or 3930.8B, both dated after OPNAV Instruction 3960.8.

The basic objectives of OPTEVFOR participation in T&E throughout a system's life cycle are given as:

(1) Ensuring that early and realistic operational tests and evaluations are planned.

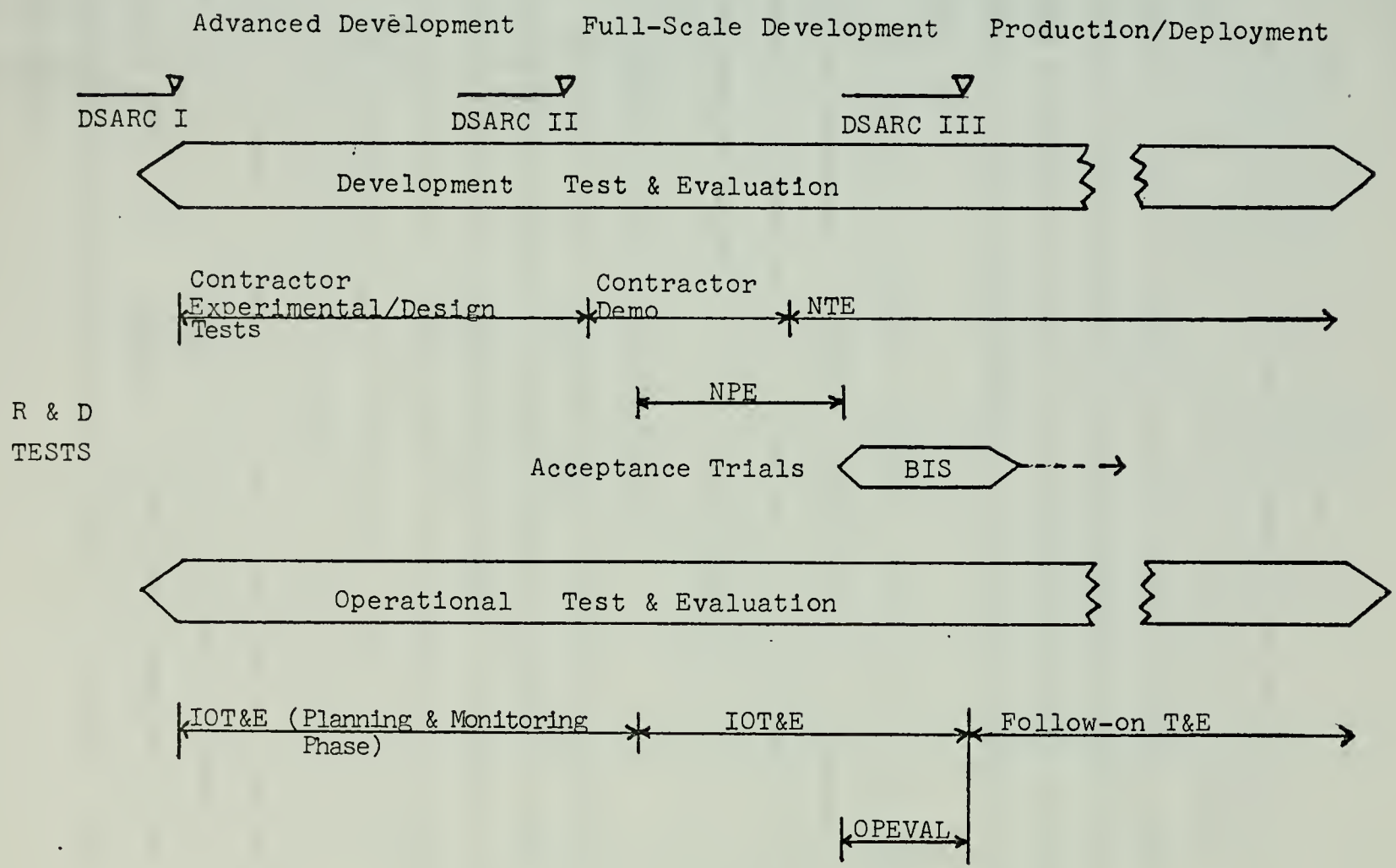
(2) Ensuring that appropriate initial operational tests and evaluations are conducted prior to scheduled decision milestones, i.e. program initiation decision, full-scale development decision, and production decision

(3) Providing an independent assessment of the operational effectiveness and suitability of the system to the CNO [Ref. 11].

The role of the Board of Inspection and Survey (BIS) for conducting acceptance trials on new ships and new model aircraft prior to Navy acceptance from the contractor is briefly discussed in this instruction. OPTEVFOR conducts OT&E to determine operational effectiveness and suitability, and BIS conducts T&E to determine acceptance for service use. It is recognized that these are closely related objectives, and this instruction directs that care be taken to preclude duplicate testing. One method outlined to accomplish this is the preparation of the Test and Evaluation Master Plan (TEMP) which is the responsibility of the Project Manager who works for the Chief of Naval Material.

Figure 2, adopted from OPNAV Instruction 3960.8, shows the normal sequence of test events in the acquisition of an aircraft weapon system.

The Director, RDT&E (OP-098) is assigned as the focal point for T&E policy and guidance for CNO. Under OP-098 the Test and Evaluation Division, OP-983, is assigned the



NAVAL AIRCRAFT WEAPON SYSTEM T&E CYCLE

FIGURE 2

specific ressponsibilities of coordinating the overall Navy T&E effort.

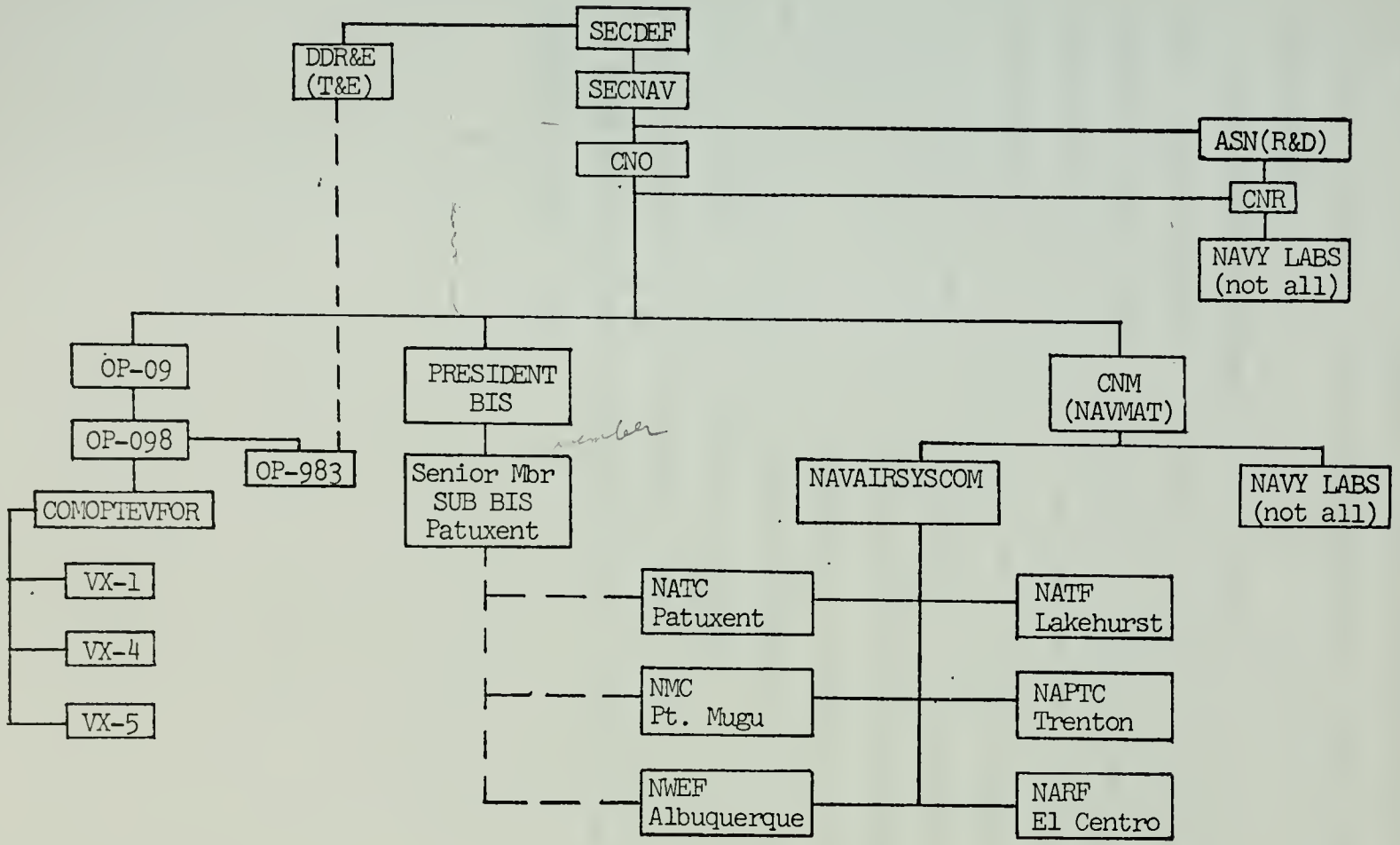
D. OPNAV INSTRUCTION 5440.47D [Ref. 12]

OPNAV Instruction 5440.47D promulgates the mission and functions of OPTEVFOR. OPTEVFOR's mission is to "operationally test and evaluate specific weapon systems, ships, aircraft and equipments, including procedures and tactics, where required; and, when directed by CNO, assist development agencies in the accomplishment of necessary Development T&E" [Ref. 12].

The Director, RDT&E, (OP-098) is the OPNAV focal point for the Commander, OPTEVFOR. COMOPTEVFOR is, however, authorized direct access to CNO and all subordinate offices as necessary to perform his assigned mission.

E. SYNOPSIS OF NAVY IMPLEMENTATION

The Navy had the simplest job of any of the Services in implementing changes to its T&E process so that it would conform to the new acquisition philosophy. Basically, the only organizational change made by the Navy was the creation of the relatively small (10 officers) OP-983, Test and Evaluation Division in the office of CNO's Director of RDT&E. Figure 3 shows the present organizational structure for the major activities that are involved in aircraft weapon system T&E. Appendix D contains a summary of the functions and responsibilities of each of the major test activities.



PRESENT NAVY T&E STRUCTURE FOR AIRCRAFT WEAPON SYSTEMS

FIGURE 3

The role of OPTEVFOR has been greatly expanded and the roles of the other Navy T&E agencies have remained essentially unchanged by the implementation of the new T&E instructions.

The Program Managers in the S-3A and F-14 programs faced the challenge of modifying their test programs to include the new OT&E requirements. In both programs the leadership displayed by the program office in soliciting the necessary cooperation from the many T&E agencies was the primary ingredient which enabled the injection of the increased OPTEVFOR testing which had not been planned for previously. In the F-14 program the necessary cooperation was obtained through the formal establishment of the Joint Evaluation Team (JET) which was composed of test personnel from the Naval Air Test Center, Naval Missile Center, and Air Test and Evaluation Squadron Four (VX-4 who works for OPTEVFOR) [Ref. 13].

IV. ASPECTS OF CURRENT NAVY AIRCRAFT T&E POLICY

Many deficiencies still exist in the Navy's T&E process, and others are being generated as a result of the new T&E policies. This section will discuss some of the deficiencies that exist in the Navy's T&E process as well as some of its enhancing characteristics which have not been changed.

A. ORGANIZATIONAL DEFICIENCIES

Because of the fragmented manner in which aircraft T&E is organized in the Navy, many problems result. These include:

(1) The user is inadequately represented
(2) Lack of independence of the T&E organizations
(3) Duplication of T&E responsibilities
(4) Inadequate central management of NAVAIR T&E activities
(5) Adequate testing is not assured for non-major procurements
(6) Requirement for independent T&E often ignores test agency expertise
(7) No standardization in method of funding T&E agencies
(8) Navy test range management is too fragmented.

These deficiencies are discussed in the following sections.

1. The User is Inadequately Represented

In each Navy procurement a dialogue that is vital for success is that between the user and the producer. Two such dialogues must exist: an external dialogue in which the Navy is the user, and the contractor is the producer,

and an internal dialogue in which the operating command is the user and the acquisition command is the producer.

In the internal user-producer relationship the user is responsible for the operation and support of a system and is consequently also responsible for developing and stating the needs and concepts for the system. In other words the user provides the input requirements to which the producer designs the system. The producer is then responsible for the design, development, production, and installation of a system that meets the requirements of the user and that can be operated and supported cost-effectively. A constant dialogue must be maintained between the internal and external user and producer throughout the system's life cycle [Ref. 3].

The external user-producer relationship is well defined and does not appear to present any significant problems in regards to responsibility. However, the internal user-producer relationship within the Navy is not so well defined. The Chief of Naval Material (CNM) represents the producer. The management of the development and production of a weapon system becomes the responsibility of one of CNM's System Commands and the specific responsibility of a Program Manager. The Office of the CNO (OPNAV) represents the user. Within OPNAV the Director, RDT&E (OP-098) initially becomes the Program Sponsor for the development of the

system, but he will eventually lose this sponsorhsip to the ultimate user sponsor. On aircraft programs it is the DCNO for AIR (OP-05) who will become the ultimate user sponsor, and he almost always assigns a Program Coordinator from his office to coordinate each program.[1] The OPNAV Program Sponsor is responsible for determining program objectives, time phasing and support requirements, and for appraising progress, readiness, and military worth of the weapon system. The OPNAV role as the representative of the user (i.e. the operating forces) appears well established up to the time of a favorable DSARC program initiation decision. Thereafter, OPNAV often becomes more of a proponent of the system being developed rather than an impartial representative of the operating forces. This is especially true in today's environment in which Congress is taking a more active role in each major weapon system's development, and the CNO is compelled to frequently justify each Navy program to Congress. The opportunistic exploration that is often made by some members of Congress over any hint of a serious problem in a weapon system's development adds further to OPNAV's serving only as a proponent of the system and to conceal any of its problems.

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[1]The transition of Program Sponsorship from OP-098 to OP-05 should normally take effect upon the decision to procure the weapon system for service use. Of necessity there is a large period of dual interest and activity, but only one Program Sponsor has final responsibility.

OPTEVFOR, working for OP-098, is a test agency organizationally independent from the developing agency, CNM. Fortunately, OPTEVFOR is not put in a position like that of the Program Sponsor where it must conceal system deficiencies. OPTEVFOR is able to test and evaluate weapon systems while truly representing the user in determining if the weapon system is operationally suitable and whether it fulfills an operational need.

OPTEVFOR, headed by a Rear Admiral, reports to CNO's Director of RDT&E, a Vice Admiral, who is often forced into a role where he must conceal weapon system development problems or risk losing the program at the Congressional budget hearings. Therefore, much of the valuable user dialogue that is generated by OPTEVFOR during the latter stages of a weapon system's development is lost through the OP-098 filter.

The internal user-producer dialogue during the latter stages of a weapon system's development often becomes too producer oriented. The OPNAV program sponsor, forced into a system proponent role, becomes an ineffective representative of the user operational forces.

The Navy's unilineal system, in which the operating forces and the Navy's acquisition forces report to the CNO, makes a clean separation between the internal user and producer forces extremely difficult to achieve. The creation of a bilineal system in which the Chief of Naval Material (heading the producer forces) and the Chief of Naval

Operations (heading the operating forces) report to a Navy Chief of Staff appears to be the only complete solution to this user-producer dilemma. However, much improvement can be made under the current unilineal system. It is beyond the scope of this thesis to discuss a change as drastic as would be the creation of a bilineal system.

2. Lack of Independence of the T&E Organizations

The need for independent T&E has become a well agreed upon fact. As discussed in Section IIB much of the T&E conducted by the Navy has been criticized as being non-independent in that the test agency worked for the developing agency.

At the working level within the Navy's T&E structure there is little concern for lack of independence. No evidence indicates that T&E conducted by any test agency is biased and that the project team's reported results are not accurate results of tests conducted to the best of their ability. Navy program managers attest that the T&E conducted by the NAVAIR T&E agencies is "independent", i.e. the P. M. is unable to influence the results. No one has really questioned the independence of the test personnel and their ability to conduct and report the actual test results they obtain. However, Congress has viewed the NAVAIR T&E agencies as not being independent, since the management wiring diagram shows them working for the developing agency. The accurate assumption is that NAVAIR has the power to completely disregard its DT&E agency test results, and the DT&E agency has no recourse.

A complete organizational separation is required to achieve the independence that is being sought by each of the critics of the Navy's T&E process. This is exactly what the Navy did in assigning the increased OT&E responsibility to OPTEVFOR, an agency that is organizationally separated from the aircraft developing agencies, NAVAIRSYSCOM and NAVMAT.

However, OPTEVFOR is not a truly independent test organization. The Commander, OPTEVFOR reports to OP-098, who is the program sponsor and was shown in the preceding section to play a producer-oriented system proponent role during OPTEVFOR's involvement in the system's development. Although OPTEVFOR reports the results of its T&E directly to CNO, which is an acceptable procedure under DOD Directive 5000.3, the OPTEVFOR reporting Chain-of-Command (COMOPTEVFOR → OP-098 → OP-09 → CNO) is not within the intent of the current DOD philosophy. If COMOPTEVFOR must report to and through OP-098, he cannot be considered legitimately independent of the developing agencies [Ref. 14], since he cannot convey the results of his T&E with enough force to effect a change in the system's development.

An examination of OPTEVFOR's funding and available physical resources shows further the inability of OPTEVFOR to perform as a truly independent test agency. OPTEVFOR does not maintain complete fiscal control and management of all funding required for OT&E. In fact, all applicable costs expended for OT&E have never been separately identified.

Without control of all the OT&E funding, it would appear that OPTEVFOR cannot independently plan and conduct OT&E. In any program whoever controls the funding controls the destiny of the program.

Lack of control of the major portion of the physical resources required for OT&E (instrumentation, ranges, data processing centers, simulators, and test aircraft[1]) further reduces the independence of OPTEVFOR. A major portion of the physical resources utilized by OPTEVFOR is controlled by the developing agency. Yet, no formal mechanism exists for the development of integrated plans for the utilization of these limited resources by OPTEVFOR and the DT&E agencies.

3. Duplication of T&E Responsibilities

Much duplication of responsibilities exists among the major participants in the Navy's T&E process: the contractor, NAVAIR T&E agencies, OPTEVFOR, and Board of Inspection and Survey (BIS). The limited availability of personnel and physical T&E resources dictates that the Navy must eliminate needless duplication in order to achieve optimal utilization. Flight testing is the most expensive type of aircraft testing, and this is the area that will be given primary attention.

The contractor is required to demonstrate satisfactorily each segment of an aircraft's flight envelope

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[1]Test aircraft are not permanently assigned to OPTEVFOR for IOT&E but only for follow-on T&E.

(airspeed, altitude, normal accelerations, gross weights, etc.) before Navy test pilots are permitted to operate the aircraft within each flight regime [Ref. 15]. Although valuable in promoting safety and obtaining additional data under identical test conditions, this regulation causes many Navy test flights to be mere duplication of contractor test flights.

Contractors are routinely required to redemonstrate compliance with the aircraft's flight structural and performance requirements at the Naval Air Test Center, Patuxent River, Maryland, after they have already performed the same tests at their own facility. This procedure is continually claimed by contractors to be a superfluous expense which could be eliminated by having the Navy witness these demonstrations at the contractor's facility. The Naval Air Test Center has been an avid supporter of the need for this duplication of contractor tests for these reasons:

(1) More credence can be placed upon results when tests are conducted at the Navy's facility rather than the contractor's.
(2) These limited demonstrations verify the contractor's instrument calibrations and put more credibility on all data collected at the contractor's facility.

Compounding the contractor flight demonstration problem is the inability of the various Navy Plant Representative Offices (NAVPRO's) to witness competently all of the contractors' flight test demonstrations. This is the result of the limited flight test and aerodynamic expertise that is available at the NAVPRO's. The various test agencies

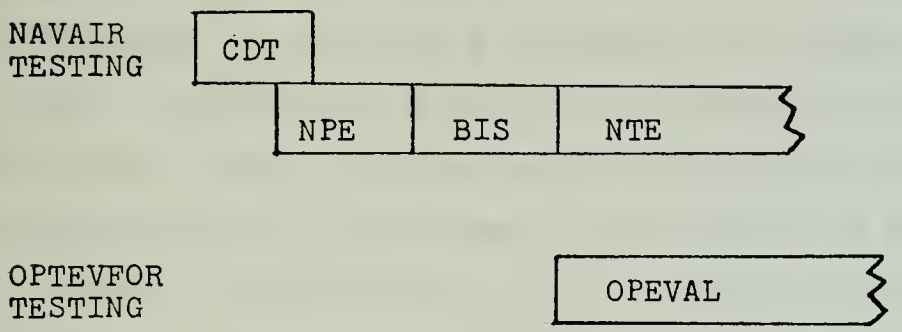
would, therefore, be required to send numerous qualified personnel to witness these types of demonstrations if they were conducted only at the contractor's facility.

The distinction between OT&E and DT&E implies two markedly different approaches to T&E which requires the need for separate test programs [Ref. 16]. Therefore, OT&E has been conducted primarily by OPTEVFOR and DT&E by the NAVAIR T&E agencies. Prior to DOD Directive 5000.1, there was a certain amount of duplication in the test programs of OPTEVFOR and the NAVAIR T&E agencies. This was unavoidable since completely different people were conducting tests on the same system, and a learning curve had to be developed by each of the respective testers. This same type of duplication exists today and will continue to exist as long as separate agencies are performing tests on the same weapon systems.

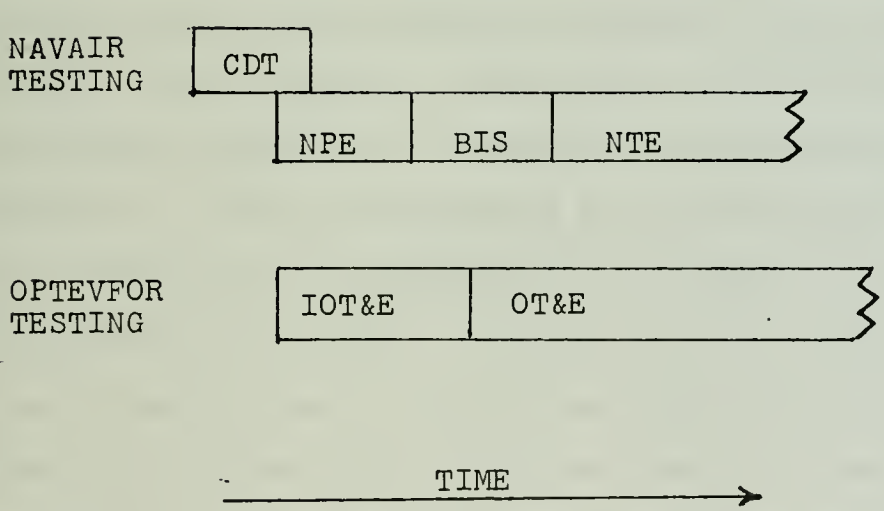
Before DOD Directive 5000.1, the tests were conducted in a sequential order and little overlap existed between the time-phasing of the tests conducted by the NAVAIR T&E agencies and OPTEVFOR. With the current requirement of conducting Initial Operational Test and Evaluation (IOT&E) prior to the production decision, the amount of time overlap between OPTEVFOR and NAVAIR testing has greatly expanded. Figure 4 gives a presentation of the conduct of the various phases of T&E before DOD 5000.1 and today.

The increased time overlap has increased the amount of duplication in testing. In the case of an aircraft both

Testing Sequence Prior to DOD Directive 5000.1



Current Testing Sequence



TESTING SEQUENCE

FIGURE 4

OPTEVFOR and NAVAIR test agency flight crews (each agency needs more than one flight crew to assure corroboration of subjective evaluations) must conduct tests concurrently throughout the aircraft's evolution – prototype to production model – and the many iterations of design in between. Valuable flight test time must consequently be devoted to developing each flight crew's experience with each iteration of design in the aircraft prior to conducting meaningful tests.

The most obvious duplication in Navy T&E is the very similar testing objectives that exist for both BIS and OPTEVFOR. BIS, utilizing NAVAIR T&E agencies to perform the test and evaluation, is responsible to "discover and report deficiencies at the earliest possible time so that corrective action can be taken to ensure that aircraft delivered to operating units will be capable of carrying out the intended mission..." and to "recommend to the Secretary of the Navy the conditions of acceptance or rejection of a model aircraft for service use" [Ref. 17]. The majority of the pilots conducting the tests for BIS are graduates of the U. S. Navy Test Pilot School where they are taught to test for service suitability first and contract compliance second.

OPTEVFOR is responsible through its IOT&E for assessing the operational suitability of an item prior to the production decision and to "evaluate the operational effectiveness, suitability, and capability of tested weapons systems to meet stated needs and performance criteria" [Ref. 12].

The difference between BIS's service suitability testing and OPTEVFOR's operational suitability testing is not apparent. The difference between BIS's testing for specification compliance and OPTEVFOR's testing against the stated needs and performance criteria is also not apparent. With the testing objectives being so similar, one can only expect duplication in the testing. Confusion often exists as to what testing is OT&E and what is DT&E, which tends to conceal much of the duplication in T&E responsibility. This confusion is illustrated by a quote from the Blue Ribbon Defense Panel which erroneously thought BIS was conducting OT&E. "Before Navy aircraft and ships are approved for use by the operational forces, they are subjected to another kind of operational evaluation which is much closer to true OT&E. This is done by a Board of Inspection and Survey (BIS), which is composed of experienced officers with appropriate Navy backgrounds" [Ref. 4, p. 23].

In attacking the problem of duplication of T&E responsibilities, the objective should not be to eliminate all overlap or duplication. It should, however, be to ensure that where such overlap or duplication exists, it is visible, controlled, purposeful, and contributes to improving the overall T&E process.

4. Inadequate Central Management of NAVAIR T&E Activities

The Naval Air Systems Command Test and Evaluation Coordinator was formally established in 1968. The Commander, Naval Air Test Center, Patuxent River, Maryland, was assigned

this additional duty, and was given a T&E Coordinator's staff to assist in the performance of these duties which were separate and distinct from the other functions performed at Patuxent River. The creation of the T&E Coordinator stemmed from the recognition of the lack of a single focal point or reviewing authority for T&E in NAVAIR and the consequential lack of coordination among the NAVAIR T&E agencies [Ref. 18].

The NAVAIR T&E Coordinator's Charter [Ref. 19] designates the T&E Coordinator as the focal point for all NAVAIRSYSCOM responsibilities in the coordination of T&E matters. It should be observed, however, that the T&E Coordinator is only a coordinator and has no line management authority over any of the NAVAIR T&E agencies, except NATC which he commands. The T&E Coordinator is responsible for assisting in the preparation of test planning in order to ensure optimum utilization of resources and minimum duplication of tests. However, the T&E Coordinator only recommends which agency should do the tests, and NAVAIR makes the final determination.

The lack of a single management focal point for T&E within the internal NAVAIR organization continues to exist. Since NAVAIR has refused to delegate to the T&E Coordinator the authority to manage its T&E activities, many duplications of testing responsibilities exist and needless interagency conflict often exists. For example, NATC and NMC are assigned similar missions [Ref. 15, p. G-13]:

NATC: "Coordinate and perform test and evaluation of aircraft weapons systems, their components and related equipment, . . ."

NMC: "To perform test, evaluation, development support and exercise engineering cognizance as assigned of Naval weapons, weapon systems, and related devices."

NMC has test responsibility for missiles and the interfaces with the various launch platforms (aircraft) while NATC has test responsibility for the aircraft and the interfaces with the various weapons that it will deliver. Because of the large overlap in responsibility, much conflict has arisen in the past between Weapon System Test (WST - a division of NATC) and NMC. Participants in the F-14/Phoenix Missile Test program have stated that more conflict existed between these two NAVAIR T&E agencies than between either NATC or NMC and VX-4 who reports to OPTEVFOR.

Another example of NAVAIR duplication of testing responsibilities exists in the area of aeromedicine. Below is a list of the agencies directly involved with the T&E of life support and aircrew protective equipment:

Naval Aerospace Recovery Facility, El Centro, CA. - conducts DT&E on escape and recovery systems (see Appendix D)

NATC - Aeromed Branch of Service Test Division

NMC - Life Support and Life Sciences Department

NADC, Warminster - Although not reporting directly to NAVAIR, NADC receives approximately 85 percent of its funding from NAVAIR and does extensive development and testing in the field of aeromedicine

Each of these agencies is involved with the development and T&E in the aeromedical area. The need to have aeromedical capabilities and expertise at each of these facilities is

questioned as needless duplication which is permitted to exist and expand because no central authority is controlling NAVAIR's T&E activities.

5. Requirements for Independent T&E Often Ignore Test Agency Expertise

LTGEN Alfred Starbird (USA-Ret) is the Deputy Director of Defense Research and Engineering, Test and Evaluation (DD(T&E)) in the Office of the Secretary of Defense (OSD). As DD(T&E) he has become a main driving force in ensuring that each of the Services conduct T&E in accordance with DOD Directive 5000.3.

DD(T&E) is responsible for reporting to the DSARC "at each major milestone decision point his assessment as to the adequacy of the identified critical issues and questions to be resolved by test and evaluation, test plans and schedules, and the adequacy of the accomplished T&E to justify the action recommended for that milestone decision" [Ref. 6]. OPTEVFOR, as the Navy's independent operational T&E agency, is the main source of DD(T&E)'s T&E data. Although much of the development agency's T&E data are made available to DD(T&E), it is the OPTEVFOR evaluation that is required before DD(T&E) will be satisfied that adequate T&E has been accomplished to meet a milstone T&E objective. In the event of a conflict, the OPTEVFOR opinion will take precedence.

As will be discussed in Section IV.B.4, OPTEVFOR often lacks the technical expertise to conduct a particular test of a system or subsystem. Yet DD(T&E) has, in the past,

required that OPTEVFOR conduct an evaluation before continuing with the development program, since DD(T&E) was not satisfied with only the results from an NATC (a developer's T&E agency) evaluation. In other words, OPTEVFOR is being tasked to conduct T&E on the basis of its independence rather than on its testing capability. The result of such actions is that OPTEVFOR is being compelled to build up its technical expertise and expand its testing capabilities into areas where this capability and expertise exists in other test agencies.

The distinction between OT&E and DT&E is not always apparent. Many T&E milestones for aircraft procurements could easily be shown to be met by conducting only so called development testing; e.g. meeting a performance requirement of maximum airspeed or altitude. However, as long as DD(T&E) requires the opinion of the independent test agency, OPTEVFOR, the Navy will be forced to increase the capability of OPTEVFOR. This will, in turn, further increase the duplication of responsibilities between OPTEVFOR and the development test agencies.

6. Adequate Testing is Not Assured for Non-Major Procurements

DOD Directive 5000.1 and the various implementing instructions pertain to major programs (RDT&E cost in excess of 50 million dollars or production cost in excess of 200 million dollars). However, all the directives state that the principles are to applied to all programs. Since DSARC is only involved with major programs, there is no exogenous

system to ensure that adequate and independent T&E is conducted prior to making the advanced development or the production decision for non-major programs.

The lack of any explicit policy for T&E of non-major systems has given considerable latitude to the Program Manager. Many projects are not subject to automatic project assignment by CNO; and consequently OPTEVFOR is often not cognizant of the existence of projects or their need for operational evaluation. OP-983 publishes a quarterly list of all assigned RDT&E projects to be prosecuted by OPTEVFOR, but no means exists for ensuring that every project requiring an operational evaluation is so assigned. What this means is that the Program Manager is able to conduct inadequate T&E, or he can even obtain T&E from a number of agencies until he receives the results he desires; and his actions may not even be criticized.

Without questioning the integrity of the Navy's Program Managers, one can certainly speculate on the outcome of a situation where the Program Manager is typically facing a cost growth combined with a slippage in schedule but has no clearly established requirement to obtain an "independent" test and evaluation of his system. His likely course of action would be to obtain the least expensive (to his program) suitable T&E that is available. Within the current Navy T&E structure many avenues to conduct T&E are open to the Program Manager: a NAVAIR T&E agency, OPTEVFOR, or a fleet unit.

The following is an example which occurred in 1970 in the development of the night carrier landing simulator for the A-7E airplane. The Program Manager had the fleet replacement A-7 training squadron (VA-122) conduct the Navy's test and evaluation. The Naval Air Test Center and specifically the Carrier Suitability Branch, the technical experts for testing aircraft and associated systems for use in the carrier environment, did not participate in the test and evaluation of the night carrier landing simulator. The VA-122 T&E was certainly less expensive than would have been T&E conducted by a NAVAIR test agency. In addition the likelihood of uncovering deficiencies (costly to the Program Manager to correct) with the simulator was far less by having untrained testers conducting the evaluation than it would have been if the critical voice of NATC had been given the opportunity to speak. Although the A-7E night carrier landing simulator has proven to be a valuable system, the example does illustrate how the Program Manager has the latitude to bypass his own NAVAIR test agencies as well as OPTEVFOR.

Another illustration of the Acquisition Manager's (the Program Manager for lower cost programs) latitude in conducting T&E is the case of the HLU-196A/E Powered Bomb Hoist. The success of this hoist is essential for the implementation of the Improved Rearming Rate Program aboard the Navy's attack carriers. T&E of the Bomb Hoist was conducted by NATC and the Naval Weapons Evaluation Facility

(NWEF) [Ref. 20]. NATC recommended against clearance of the HLU-196A/E for use with all explosive ordnance and NWEF recommended restriction against use of the hoist with nuclear weapons until certain safety deficiencies were corrected. Yet, the feature article of the April 1973 edition of Naval Aviation News [Ref. 21] reported that carrier testing of the HLU-196A/E had been very successful and implied that NATC and NWEF had obtained similar results in their tests. Apparently the four-day HLU-196A/E evaluation conducted aboard USS Enterprise during combat operations by operational Navy ordnancemen showed the HLU-196A/E to be very effective. The design deficiencies (high failure possibility of two critical springs) which NATC and NWEF considered to have such an adverse effect on safety never showed up in this "operational evaluation."

It appears that the Acquisition Manager was unwilling to accept the negative T&E results from NATC and NWEF. Hopefully, the serious design deficiencies in the HLU-196A/E can and will be corrected before a catastrophic accident occurs. One would like to believe that the acquisition manager has not considered his system's design complete, merely because someone was found to report his system as being a "significant step toward a mobile automatic weapons loader" [Ref. 21, p. 14]. However, the Navy's acquisition process for non-major procurement provides an inadequate check to protect against prematurely terminating the correction of deficiencies.

7. Methods of Funding

As pointed out in Section IV.A.2 and IV.A.3, the costs for conducting T&E cannot be totally identified. Further compounding the situation is the fact that many different methods are used for funding the various T&E agencies. Some development T&E agencies are operated under Navy Industrial Funding where both direct and indirect costs are charged to each T&E project, and the funds are then transferred from the respective Program Manager. Other agencies utilize industrial funding where only direct charges are incurred by the project, while still others never even charge military personnel working directly on the project as a direct cost to the project. Consequently, the cost to conduct T&E varies significantly from agency to agency.

In the past, Program Managers have been forced by monetary constraints to have certain tests conducted by a T&E agency which was not as well suited to perform the T&E, but whose funding method resulted in much lower cost for the Program Manager and his particular program. However, it is quite possible that the overall cost to the Navy might have actually been higher, but this is not determined or considered in the Program Manager's decision making process. Obviously a system which forces a Program Manager to make decisions based upon cost tradeoffs must reflect realistic costs which, when compared, enable the Program Manager to make decisions which give valid cost savings.

The funding for OPTEVFOR is different from that of the development T&E agencies in that more funding sources are involved. The VX Squadrons, the Air Test and Evaluation Squadrons that conduct aircraft T&E for COMOPTEVFOR, receive part of their funding from their respective Type Commanders (COMNAVAIRPAC or COMNAVAIRLANT). Fleet Commanders also fund OPTEVFOR indirectly through their Operating and Maintenance (O&M) funds by providing fleet services and support for OT&E. The remainder of OPTEVFOR funding comes from the various Systems Commands to support OT&E on a project by project basis [Ref. 15]. As long as the funding for OT&E is not centrally managed, OT&E will not have fiscal accountability, and cost-effectiveness trade-offs for conducting different types of T&E will be nearly impossible to perform.

8. Navy Test Range Management

Appendix E contains a list of the major Navy ranges and physical test facilities that are utilized in aircraft weapon system T&E. The ranges are controlled by a number of different commands. The only central range authority is the Naval Material Command (NAVMAT) Navy Range Manager, who only has line management control over the NAVMAT and NAVAIRSYSCOM controlled ranges. It is significant to note that OPTEVFOR does not have control over any range or physical test facility. Consequently, OT&E is conducted at ranges and facilities which are primarily development T&E oriented. The tests are planned and conducted around the specific range

or facility requirements, rather than on the basis of what is required for optimal OT&E.

The cost to operate the ranges and physical facilities cannot be isolated, since they are buried in the budgets of the various controlling agencies. Without central range management or knowledge of the overall operating costs, it is a near impossible task to justify the various ranges and make rational decisions when forced to reduce range assets. Since the ranges available for military use determine the location and the functions of the various T&E facilities, this area is critical to T&E. During this period of increased civilian interest in the vast amount of real estate controlled by the military, it behooves the Navy to devote its best efforts to ensure that adequate ranges and facilities will exist for T&E in the future.

The under-utilization of many test ranges makes them candidates for elimination or conversion to some other use. The General Services Administration is conducting a continual survey to identify under-utilized and/or poorly utilized real property holdings of all Government agencies [Ref. 22]. The Navy must determine its total Navy Range requirements, and then determine if it has an excess or a shortage. With so many Navy agencies controlling ranges and facilities, it becomes a difficult task to separate the actual Navy range requirements from the internally generated requirements where each agency tries to "keep what it has."

B. OTHER DEFICIENCIES

Besides the organizational features of the Navy's T&E process many other phenomena exist which cause the Navy's T&E process to be deficient. This section will discuss these other deficiencies:

(1) Overlap between DT&E and OT&E
(2) Inadequate Test Planning
(3) Inadequate operational test objectives
(4) Inadequate technical expertise in OPTEVFOR
(5) Lack of a Weapon System Test and Evaluation School
(6) Late test results
(7) BIS scheduled prior to DSARC III
(8) Shortage of analysts
(9) T&E not always treated as a continuing process

1. Overlap Between OT&E and DT&E

Perhaps the greatest problem facing military T&E today is the lack of a uniform understanding of the differences between OT&E and DT&E. The definition of OT&E and DT&E presented in Appendix B may seem quite explicit to the uninitiated. The consensus throughout the Navy's aircraft T&E community, however, is that the major portion of T&E conducted by the military falls somewhere in a "grey area" that is not purely DT&E nor purely OT&E.

Since the majority of T&E, therefore, is conducted in an area that is not clearly the responsibility of the DT&E agency or the OT&E agency, parochial attitudes are typical and often hinder cooperative testing. Each agency attempts to lay claim to the larger or certainly the more desirable portions of the system's particular testing

equirements. There exists a definate tendency for opera-
ional test pilots to want to become more involved with the
ore glamorous experimental or developmental testing.
ecently, more and more pilots with only VX/operational T&E
ackgrounds have been accepted for membership in the Society
f Experimental Test Pilots, an organization which requires
xtensive experience in developmental or experimental flight
esting for full membership. These VX pilots have acquired
he requisite experimental and developmental test pilot
xperience, but they did it while in operational test pilot
illets.

A similar tendency exists on the part of the develop-
ent test agencies. The development test pilot/NFO (Naval
light Officer) resents being put into the current situation
here he feels that he is asked only for technical opinions,
nd OPTEVFOR is relied upon for operational opinions. The
evelopmental T&E project officers have operational back-
rounds comparable with those of the operational T&E project
fficers in OPTEVFOR. The only significant difference is
hat the DT&E project officers spend a year in Test Pilot
chool after leaving their last operational billet and prior
being assigned to a DT&E agency. Consequently, the DT&E
roject officers adamantly refuse to accept roles that are
olated from operational suitability, and they tailor their
sts to look at the operational aspects as well as the
chnical aspects of a weapons system.

This cross-pollination of mission roles between the DT&E agencies and OPTEVFOR probably causes each side to become better "military T&E" organizations. However, the U. S. Navy cannot afford the luxury of developing this expensive duplication. As long as separate agencies are being tasked to perform T&E which does not lend itself to an easy separation into DT&E and OT&E, parochialism will continue to grow at the expense of T&E efficiency in terms of cost and performance.

2. Inadequate Test Planning

DOD Directives 5000.1 and 5000.3 require early planning for T&E. Prior to the DSARC I Program Initiation decision the critical questions and areas of risk that have to be resolved by T&E must be identified. At this time the test objectives, schedules, and milestones must also be determined. This can only be accomplished through extensive early test planning with the assistance of the T&E agencies.

Unfortunately, the T&E agencies are not involved in the early stages of test planning. A Test and Evaluation Master Plan (TEMP) is required to be prepared as early as possible in the acquisition cycle. It is a management document which describes how and when developmental and operational test objectives will be met, and its preparation is the responsibility of the development agency's Program Manager [Ref. 11]. The T&E agencies become involved only through a review and comment process rather than being

intimately involved in determining test objectives and how best to determine if they are met.

To translate this situation into the commercial DOD market place, when DOD procures something for a contractor, the user, in this case DOD, tells the contractor or producer what tests will be performed to demonstrate the acceptability of the particular item. The contractor may assist in the structuring of the tests or in recommending substitute tests, but the responsibility for test planning to determine service suitability clearly must remain with DOD. In going back to the Navy's internal situation, a similar situation should but does not exist. The producer, in this case the developing agency, has the responsibility of preparing the test plan for each particular system. The user, in this case OPNAV, merely assumes a review and comment role.

Certainly the Program Manager must retain the responsibility for test scheduling and for satisfactorily meeting the test objectives. However, the user and the T&E experts should have the primary responsibility for the determination of the test objectives and how, when, where, and by whom they can best be tested to determine if they are being met satisfactorily.

3. Inadequate Operational Test Objectives

The preceding section discussed the inadequacy of test planning in the early stages of a system's development. This has a most adverse effect on OT&E. Very frequently

OPTEVFOR is tasked to perform an "operational evaluation" on a system or subsystem, but a standard against which to test does not exist. Unfortunately, the operational requirements for many weapon systems are never well promulgated nor explicitly defined.

The Specific Operational Requirement (SOR) is the requirement document from CNO to which a system is designed. The SOR is supposed to define the required weapon system capability in terms of mission requirements, operational concept, and performance constraints [Ref. 23]. It would appear that the SOR would be the "standard" against which OPTEVFOR could design its tests. In reality, the SOR is often incomplete or outdated by the time the system is ready for any T&E, or the SOR has not been written and approved by the time T&E has commenced. One further deficiency is that the SOR usually contains little in the way of test planning or test objectives – that is left entirely to the developing agency in its response to the SOR, the Technical Development Plan (TDP).

The TDP is the developing agency's management documentation of its proposed actions and procedures, and the resources which are required in order to achieve the capability described in the SOR. The TDP is a primary planning document for the development, production, installation, integrated logistic support, reliability and maintainability, personnel training, and test and evaluation of the weapon system [Ref. 23]. The in-depth analysis that goes into the

TDP translates the requirements of the SOR (if one exists) into specific performance and development objectives against which DT&E agencies can test. However, the TDP is not the document against which OPTEVFOR should be testing.

A comprehensive analysis should be conducted early in the requirements determination phase (Conceptual Phase) to develop operational effectiveness criteria. These criteria would serve the valuable function for establishing a general method to evaluate and assess whether the system's development is meeting the operational needs. Operational effectiveness criteria should facilitate the writing of a flexible test plan which is required by OT&E. The SOR or a suitable replacement document should contain such operational effectiveness criteria. This is clearly the role of the user, i.e., OPNAV, and it should not be delegated to the developing agency.

4. Inadequate Technical Expertise in OPTEVFOR

There appears to be a common belief that the main requirement for an OT&E project officer is that he possess current fleet operational experience. While extensive operational experience is a necessity for the molding of a competent OT&E project officer, his training should also include schooling in the technical disciplines that are involved in his project; aeronautics, electronics, physics, and test methods (including statistics and test design).

It is a well established requirement that the majority of the project officers (pilots and Naval Flight

Officers) involved with DT&E are graduates of a formal Test Pilot School where the discipline of T&E is taught as are also many basic technical fundamentals. In addition each DT&E agency has an extensive civilian technical work force which is composed of aeronautical, mechanical, and electrical engineers, mathematicians, physicists, and computer specialists. An in-depth technical background has been recognized by the DT&E agencies as an absolute requirement for conducting T&E of a sophisticated weapon system.

Many OPTEVFOR project officers believe that operational test objectivity is decreased as technical expertise is increased. However, the increased T&E role that OPTEVFOR is being forced to fulfill is causing OPTEVFOR to recognize the need to increase its level of technical expertise. The number of project officers possessing both operational experience and technical capability must be expanded if OPTEVFOR is going to fulfill adequately its T&E objectives while efficiently utilizing test resources.

By designing efficient test plans, millions of dollars can often be saved, while obtaining even more conclusive results. The design of such test plans cannot be accomplished by personnel possessing only a primary attribute of recent operational experience. Operational testing should be conducted by personnel having similar qualifications to those who will ultimately utilize the system, but this should not preclude personnel from possessing

the requisite technical capabilities from designing and planning the tests and analyzing and evaluating the results.

OPTEVFOR recently evaluated a system in USS Ranger. The system's performance was believed to be affected by latitude, longitude, look angle, and other parameters. Testing for latitude and longitude effects would necessitate relocating the test force all over the world. Fortunately a project officer assigned to this program had an excellent technical background. He was able to show by some relatively simple preliminary tests that both latitude and longitude had an insignificant effect on one performance parameter in question. Latitude and longitude would affect this parameter only as a result of the consequential changes in look angle. This knowledge could provide considerable cost savings, since only look angle must be varied to complete this portion of the test. One can only wonder how many tests consist of expensive testing for the effects of parameters which could have been shown to be insignificant by a skilled analyst.

Another area where OPTEVFOR's technical expertise is lacking is in the testing of computer programs (software), which have become an integral part of every current weapon system. The results of inadequately designed tests of these weapon systems will not show where system problems exist, i.e. in the computer program, in the hardware, in the operating procedures, etc. If one is going to expend the effort and cost to conduct the tests, it is only logical to expect that the results will be able to show where problems exist, not merely

that the system operation is good or bad. In order to design adequate operational or developmental tests for computer software, an in-depth knowledge of the system operation is required, as is also a good basic understanding of the technical principles involved.

Technical expertise in OPTEVFOR can be increased by obtaining more civilian analysts and other technical specialists and by increasing the formal training given to the project officers. The assignment of only one civilian, an analyst, to each OPTEVFOR VX squadron is an inadequate core of technical expertise around which the VX squadron can perform efficiently and effectively. The recent efforts by OPTEVFOR to obtain more officers with graduate technical degrees from the Naval Postgraduate School is a move in the right direction, but much more emphasis has to be given to this area.

5. Lack of a Weapon System T&E School

Very little formal training is required or is given before project officers are assigned to an OPTEVFOR project. VX-4 project officers are probably the most formally trained in OPTEVFOR. They usually attend a two week training program at Deputy COMOPTEVFOR, North Island, California and then a formal three day training course on the operation and utilization of the Pacific Missile Range (PMR), their primary test site. But the main part of every OPTEVFOR project officer's training is "on-the-job training" – also called "learning from one's own mistakes." In the T&E environment

mistakes are too costly a teaching tool. It costs approximately $36,000 per hour to utilize the PMR. This should compel any user to ensure that his tests are conducted as efficiently and expeditiously as possible with minimal likelihood of having to repeat.

Although the majority of DT&E agency project officers have attended a formal one year course of study at a Test Pilot School, the knowledge they receive is primarily in the discipline of aircraft flying qualities and performance T&E. While this is essential to anyone becoming a project officer in the Flight Test Division of NATC, approximately two-thirds of the U. S. Navy Test Pilot School graduates go to project officer jobs where there is very little need to utilize any of the flying quality and performance test techniques. What is lacking in the training of these project officers is extensive training in the T&E of complex weapons systems. The U. S. Navy Test Pilot School has introduced a course entitled Integrated Weapons Systems, but it composes only 7 percent of the formal classroom instruction time and serves the purpose of giving the student only an introduction into the complex field of weapon system T&E (as opposed to aircraft vehicle T&E).

As with OPTEVFOR "on-the-job training" then becomes the primary training method for the DT&E project officer who becomes involved with weapon system testing. But the DT&E project officer has many distinct advantages over his OPTEVFOR

counterpart. The Test Pilot School has given the DT&E project officer considerable knowledge and experience in the field of T&E (i.e., how to plan, conduct, and analyze tests efficiently), and it has also taught him how to write concise, accurate test reports.

DT&E project officers receive more formal training than their OPTEVFOR counterparts. However, a significant deficiency exists in the training of both types of project officers. Nowhere are they taught how to test a complex weapon system, how to separate computer software problems from system hardware problems, how to design an optimal test using a statistical design of experiments approach, etc.

Not only do the project officers receive inadequate formal training, but so do the civilian engineers throughout the T&E community. Most of the civilian engineers working in the Flight Test Division of NATC complete the entire academic curriculum of the Navy Test Pilot School. However, formal training in T&E does not exist for civilian engineers at other T&E agencies. Although the civilians possess technical or engineering degrees, very few civilians reporting to a T&E agency have had any prior experience or training in the discipline of T&E. Consequently, costly on-the-job training in T&E is again the technique utilized to train the civilian engineers and analysts.

6. Late Test Results

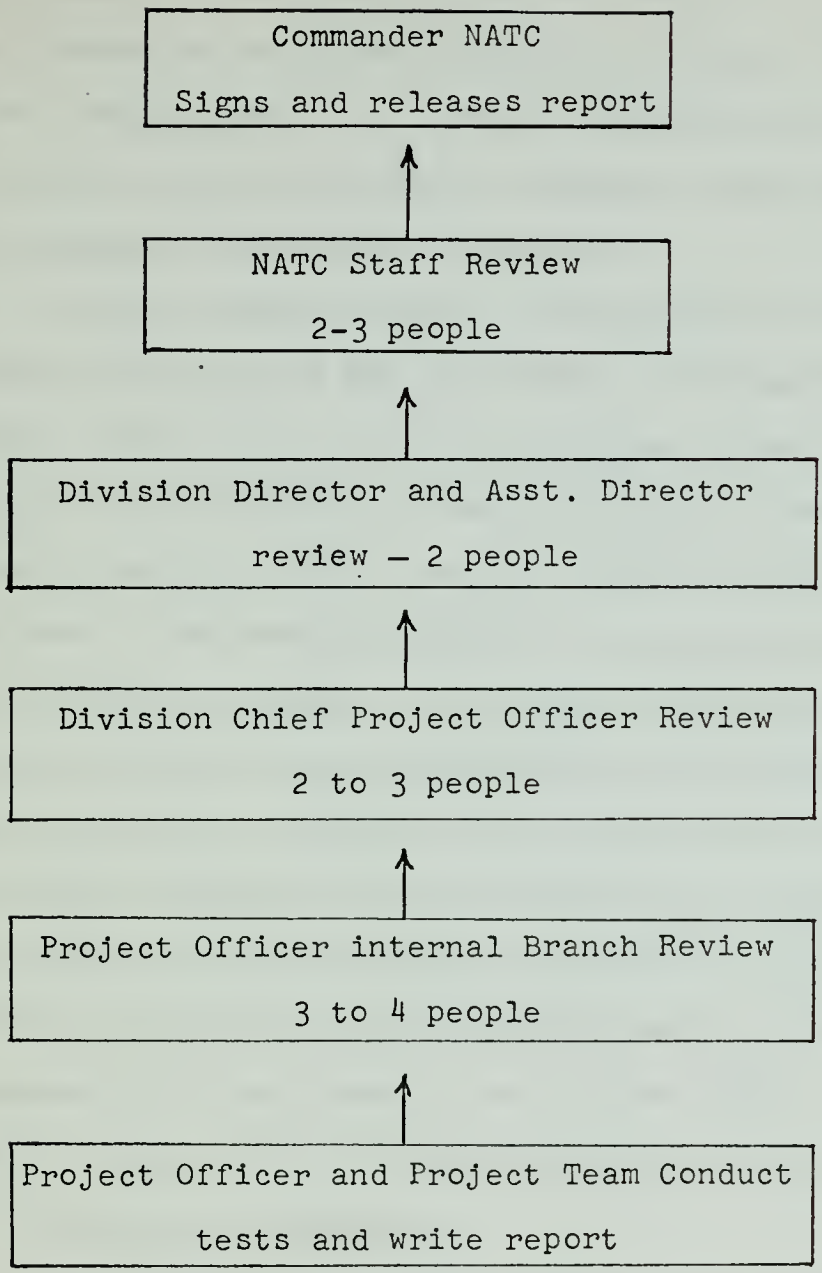
The new DOD T&E policies are intended to correct the deficiency of T&E being conducted too late to affect the

system's development. However, Program Managers are still plagued with the problem of not getting test results soon enough from the test agencies which they have requested to conduct certain tests. This is usually not a problem with NPE or BIS reports where the schedule for report submission is very rigid, and all T&E agencies are forced to comply. The problem arises with the myriad of minor T&E projects that are conducted during every major weapon system's development. The test reports from the DT&E agencies go through such a lengthy review process that they are frequently received by the Program Manager too late to assist in his decision making process. Figure 5 shows a typical DT&E agency test report review chain.

Not every test report is required to follow the complete review chain, but all of the test reports dealing with important projects do follow it. Some type of formal review chain is an absolute requirement to ensure that the test agency's main output, test and evaluation reports, do not fall below the established minimum level of quality, and to ensure that misleading statements or statements not supported by data are not made in the reports. However, when the review chain becomes so time consuming that it becomes the major obstacle in the conduct of T&E, a significant change should be made.

7. BIS Scheduled Prior to DSARC III

OPNAVINST 3960.8 shows BIS commencing along with OPEVAL prior to the DSARC III major production decision.



Typical DT&E Agency Test Report Review Chain

FIGURE 5

(See Figure 2). The function of the OPEVAL is to determine if the system is ready for production, and the function of BIS is to determine if the production aircraft are acceptable for service use and whether the system's contract specifications have been met [Refs. 2 and 20].

If this instruction is to be followed in regard to the time sequencing of BIS and OPEVAL, the functions of BIS aircraft trials will have to be modified. However, if it is modified so as to fulfill a function prior to the major production decision, this function would obviously have to be related to determining whether a favorable production decision should be made. As discussed previously (Section IV.A.3), the roles of BIS and OPTEVFOR are too similar at present, and such a change to the function and objectives of BIS would exacerbate the duplication that already exists between the function of BIS and the functions of OPEVAL. The other alternative is to have BIS remain as service acceptance trials and have it occur after OPEVAL, which is a radical change from the current sequence of aircraft T&E.

8. Shortage of Analysts

The requirement to utilize statistical analysts for designing tests and analyzing the data for statistical significance has long been known and practiced by OPTEVFOR. The DT&E agencies are still living in a world where they believe "everything" is deterministic, and very seldom is the statistical aspect of data fully analyzed. This is

typical of the entire scientific and engineering community. Only within the last five to ten years has emphasis been placed upon the probabilistic aspects of engineering.

The DT&E agencies need to devote more attention to the investigation of the statistical aspects of their tests. A large amount of DT&E testing is done where statistics (i.e. means, variances, confidence levels) are calculated, but a statistical analyst is seldom if ever used to verify the credibility of the test. While a large part of "our world" might be distributed normally,[1] in many instances this assumption can lead to some significant errors in the conclusions one draws from data.

Although OPTEVFOR has recognized the need for analysts, it still has serious T&E problems that can be traced to the lack of sufficient analysis expertise. There is presently one civilian analyst assigned to each VX squadron and four military and four civilian analysts (two are permanent Government Service employees) assigned to OPTEVFOR Headquarters staff [Ref. 14]. The problem with the analysts is twofold: (1) low experience level, and (2) inadequate numbers of analysts to perform all required functions.

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[1]Populations of random variables are distributed according to different types of statistical distributions. The Gaussian or Normal distribution is one of the most common and a great many test parameters and conditions can accurately be described by the Normal distribution. However, normality should always be tested for and not merely assumed. Incorrectly assuming a Normal distribution when some other distribution is appropriate could lead to erroneous conclusions.

The civilian analysts assigned to the VX squadrons and two assigned to OPTEVFOR headquarters work for the Operations Evaluation Group (OEG), a part of the Center for Naval Analysis (CNA). These OEG representatives are assigned to OPTEVFOR for a two year period (recently increased from only one year). For the OEG representative this two year period is his field experience tour. Generally, the OEG personnel are relatively junior when they are assigned to OPTEVFOR, and consequently a large amount of their time is spent in on-the-job training. The best career promotion opportunity for the OEG personnel appears to exist when they are assigned to jobs within CNA headquarters. Consequently, there is little motivation for an OEG representative to continue working for OPTEVFOR despite the fact that he may find his job challenging, rewarding, and essetnial. As a result of these circumstances, the experience level and caliber of the OEG representatives assigned to OPTEVFOR is less than desired.

The shortage of analysts precludes utilizing an analyst's expertise to design each of the test plans; although the analyst may try to review each test plan prior to its execution. In practice the majority of OPTEVFOR test plans are constructed by going through the files and modifying/copying a previously executed test plan. As a result, many tests are inadequately planned.

Many times the analyst is not consulted until after the test has been completed, and he is then asked to

determine what the data show. This is inadequate, since the test has to be designed to obtain data in a fashion that will permit data analysis from which valid conclusions can be drawn. However, even OPTEVFOR's Project Instruction Volume II [Ref. 24], which is a comprehensive handbook for conducting OT&E and analyzing the data, essentially overlooks this essential part of T&E, the design of the experiment.

As a result of the lack of an adequate number of capable analysts to design the tests and then analyze the data, needless expenses are often incurred, and incorrect conclusions can easily result. An example of needless expense is the recent OPTEVFOR testing of a missile which was supposed to demonstrate a kill probability of 0.4. Fifteen missiles were obtained to conduct the tests and all fifteen were fired. The test personnel reasoned that if six or more "hits" were obtained, a kill probability of 0.4 or greater would have been demonstrated. (6 hits/15 Missile Firings = Hit or Kill Probability Pk = 0.4.) A simple sequential test could have been designed where the firing of each missile was dependent upon the results of the previous firings. After each firing one of the following decisions could be made: accept the hypothesis that Pk is greater than or equal to 0.4, reject the hypothesis, or fire another missile. As an illustration of this test plan assume the first six missiles resulted in misses. This would demonstrate at a 95 percent confidence level that the kill probability is less than the required 0.4. This result is

obtained by using the binomial distribution with six failures out of six attempts and a test hypothesis that Pk is greater than or equal to 0.4. In this case, it would be a needless expense to fire any more than six missiles. If all fifteen missiles were fired, the last nine would essentially be wasted, since no greater statistical significance would need to be achieved. The actual missile test resulted in some "hits," but more missiles were fired than was necessary to reject the test hypothesis that the Pk was greater than or equal to 0.4.

9. T&E, Not Always Treated as a Continuing Process

In order for T&E results to be used to accurately predict or assess a weapon system's operational effectiveness, continuous monitoring of the system's development progress must be maintained. Snapshot looks at the weapon system at infrequent intervals will not give a valid assessment of a system's potential.

Making accurate assessments of a system's military worth and operational effectiveness requires considerable T&E experience on the part of the evaluator. As an illustration of the need to monitor continually the development progress of a weapon system, this section will briefly describe the availability growth that should be tracked in every development program.

Operational Availability (Ao) is defined as the ratio of the total time the system is capable of performing its function (uptime) to the total time when there is a

demand for the system (uptime plus total down time which includes maintenance/logistic delay times). Availability can also be expressed as "the probability that the system will operate satisfactorily at any point in time when used under stated conditions" [Ref. 25].

Mathematically operational availability is defined as follows:

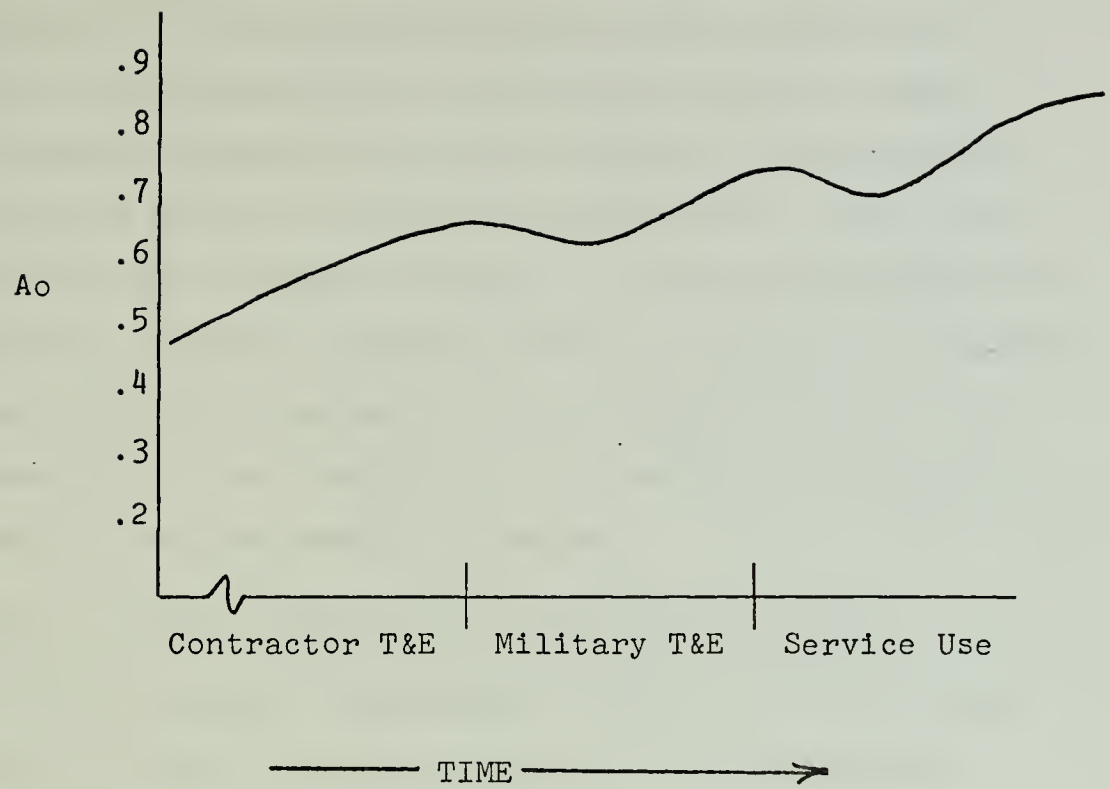
$$Ao = \frac{MTBM}{MTBF + MDT}$$

where: MTBM = mean-time-between-maintenance (includes corrective and preventative maintenance)

MDT = mean-down-time including maintenance and logistic delay times

Figure 6 is an illustrative time history of a system's operational availability growth during its development and initial deployment. Typically, the operational availability will not be a linear function.

The evaluator needs considerable experience to accurately interpret such growth time histories. In the included example the dip in the curve after commencement of military T&E is typical and is usually caused by the problems attendant with the new operator developing his learning curve in operating the system. The learning curve phenomenon occurs again after the system is introduced to the fleet and a similar dip in operational availability is



Operational Availability Growth of Typical
Aircraft Weapon System

FIGURE 6

is usually encountered. In this case increased system familiarity by the fleet results in more critical demands on system performance and consequently more deficiencies/ failures in the system will be detected. The rapid usage of the spares reduces the level of spares to the point that it adversely affects operational availability. This example illustrates why frequent tracking of operational availability rather than occasional snapshot looks is required to accurately evaluate a system's operational availability growth. This also applies to the tracking of a system's other operational suitability and performance parameters.

C. GOOD FEATURES OF THE NAVAL AIRCRAFT T&E PROCESS

Although numerous deficiencies exist in the Navy's T&E process for aircraft weapon systems, many good features exist:

(1) Navy test pilots and NFO's (Naval Flight Officers) typically have and maintain excellent operational backgrounds
(2) Testing is conducted by relatively small organizations
(3) Competition among test agencies stimulates good performance
(4) Decentralized test management is practiced
(5) T&E attracts top caliber military personnel.

The Navy's developmental and operational test pilots and NFO's are required to have recent operational experience before receiving orders to a T&E project officer's billet. Pilots and NFO's are selected for admission to the Navy Test Pilot School on the basis of their operational, academic, and flight backgrounds. After graduation the engineering

test pilot or test flight officer is assigned to a project officer's billet in one of the T&E Divisions at NATC, or occasionally NMC. Within three years the pilot or NFO is ordered back to an operational billet. In this way, the Navy keeps bringing current operational experience into its DT&E community, and test pilots do not remain in test billets for extended periods of time, so that they do not lose their operational perspective. The Air Force operates considerably different in that many of their test pilots spend the majority of their flying careers assigned to T&E billets, and they do not get re-exposure to operational environments. (The Viet Nam crisis somewhat changed this in that most Air Force test pilots were given one year tours of duty in Southeast Asia).

Navy aircraft T&E is conducted by relatively small organizations where the project officer has ready access to the Commander of the test activity. The so called "can do" attitude is evident in each of the T&E activities. This attitude is generally easier to develop in a small organization than in a larger bureaucratic organization.

Since many T&E activities have similar capabilities, competition is generated between these activities in trying to solicit more project work, obtain greater test capabilities, etc. This competition assists in causing each activity to become more cohesive, more work and task oriented, and better organized. Loyalty and pride in one's test activity

is prevalent and further facilitates good performance from a test activity.

The project officer and his team plan and conduct individual tests. High level T&E management develops and approves the TEMP and other broad T&E guidelines, but within these bounds the project officer is given essentially a free hand in the development of his test plan. This decentralized management in planning and conducting the tests causes the personnel conducting the test to be more responsible for the timely and effective accomplishment of the test objective.

The Navy has made aircraft T&E a challenging, interesting, and rewarding job assignment. Consequently, the Navy has been able to constantly attract the highest caliber personnel for jobs in the DT&E agencies and OPTEVFOR. A tour of duty in a T&E Agency is regarded throughout the Naval Aviation community as career enhancing, and this further motivates good people to seek tours of duty in T&E.

D. A PREDICTION OF THE EVOLUTION OF T&E BASED ON NO MAJOR CHANGES TO THE CURRENT T&E PROCESS

Unless major changes are made to the Navy's current T&E process, a gradual and costly evolution will occur, and the roles of the T&E agencies will be altered significantly. A basic premise of this thesis is that if the Navy can define an optimal T&E process, it should make whatever changes are necessary to achieve this process, rather than relying on a slow evolutionary process which may or may not yield a desirable end result.

Previous sections of this thesis describe how the role of OPTEVFOR has become more encompassing and how this is causing undesirable duplication among test agencies. This appears to be the start of the evolutionary process that is predicted herein.

Since OSD and DD(T&E) place primary credibility on T&E results obtained from OPTEVFOR, Navy Program Managers may soon feel compelled to task OPTEVFOR to participate in all Naval aircraft T&E. If this occurs, when a Program Manager has a system change that needs military T&E, he will probably request that only OPTEVFOR conduct the T&E. The Program Manager could have both a DT&E agency and OPTEVFOR conduct the T&E, or he might even try to arrange to have a joint OPTEVFOR/DT&E agency team conduct the evaluation. However, both these alternatives would cost more and take more time, since two T&E agencies vice one will have to analyze the data and report their results. So the Program Manager will make the cost-effective decision and have only one agency, OPTEVFOR, conduct the evaluation. Since the DT&E agency works for the developing agency, the Program Manager should have little trouble in squelching the dissension that comes from the neglected DT&E agency.

As this process continues the DT&E agencies might be forced to cut back personnel due to decreased work loads, while OPTEVFOR increases its size. OPTEVFOR might be forced to establish its own test pilot school to teach the discipline

of T&E. Soon OPTEVFOR will have technical capabilities that make it the only one capable of conducting many types of T&E.

This evolution would continue until concern arises over the highly technical T&E that is being conducted by OPTEVFOR. As a result a suggestion might appear to once again create a completely separate organization composed of military personnel with good operational backgrounds. These personnel would conduct T&E to determine if a weapon system is suitable for service use and to develop the optimum employment tactics. This new type of testing might be called Tactical Test and Evaluation (TT&E).

An examination of the current T&E environment shows that such an evolution is well underway:

OPTEVFOR is getting more and more projects.

OPTEVFOR's Personnel complement is increasing.

More technical expertise is being obtained by OPTEVFOR.

OPTEVFOR is being given more responsibilities while the DT&E agencies remain fairly stagnant.

The need for an OT&E School is becoming more apparent.

The need for a larger OPTEVFOR civilian cadre is becoming more apparent.

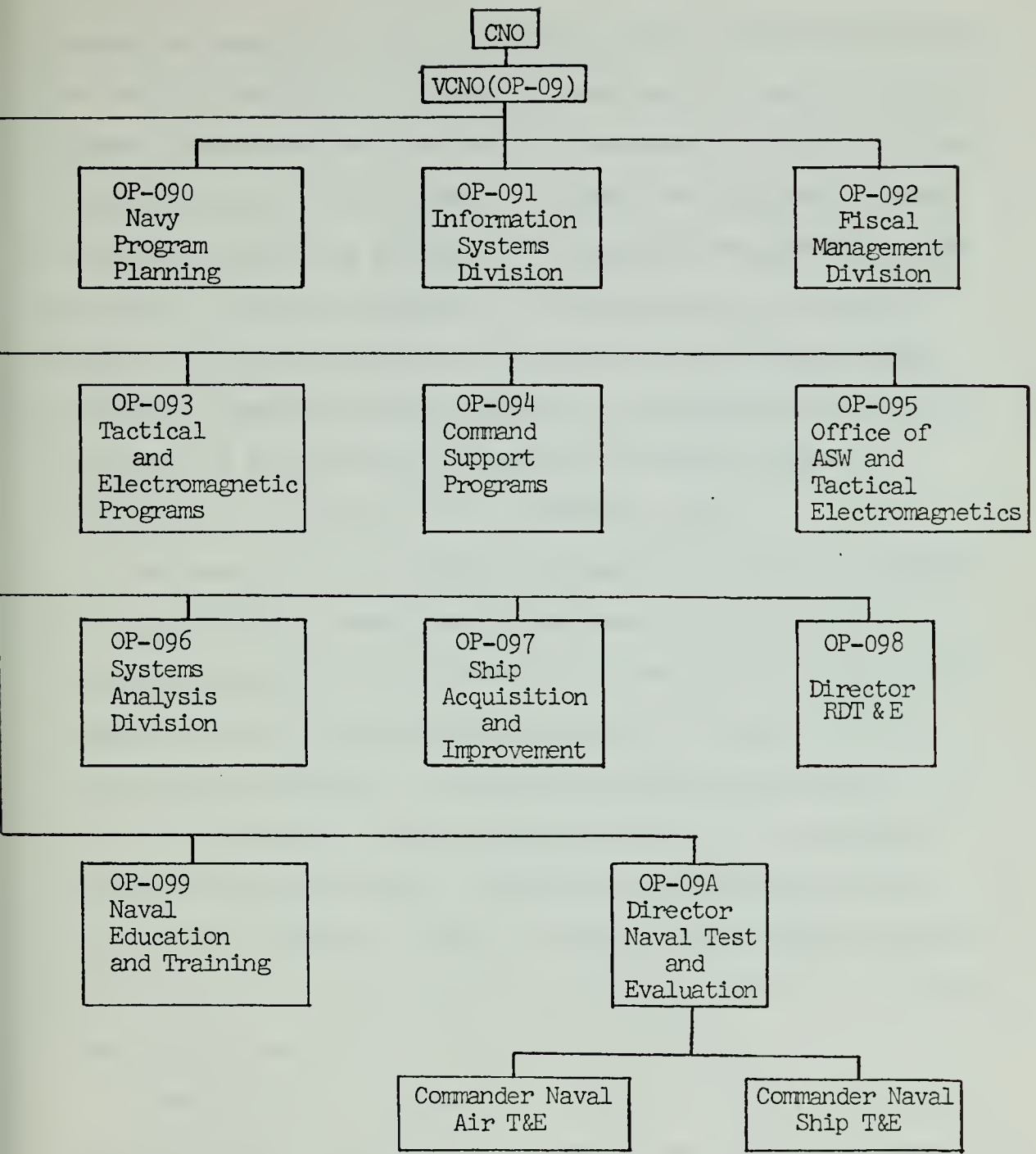
V. PROPOSAL FOR A TEST AND EVALUATION ORGANIZATIONAL CHANGE

Changes are constantly being made in order to improve Naval aircraft T&E, but the thought of a major reorganization of the T&E activities has always been met with a high degree of apprehension. However, many problems facing Naval aircraft T&E will not be eliminated unless a major reorganization takes place in the T&E community. The less than optimal utilization of the Navy's T&E resources has been depicted, and many of the causes have been cited. Since T&E agencies having similar responsibilities report to completely separate commands, it is reasonable to assume that inefficiencies in terms of duplication will be difficult to reduce. The belief that "more testing is better, so let's continue to do more and not worry so much about the duplication" is a simplistic and costly solution to the Navy's T&E problems, but one that has gained considerable support.

A proposed approach to improving the Navy's T&E of aircraft weapon systems, while achieving an optimal allocation of the Navy's T&E resources, is the creation of a Naval Test and Evaluation Command that would have responsibility for all DT&E and OT&E conducted by the Navy with the exception of the necessary T&E conducted by Navy Laboratories in fulfilling their research and development mission. The Commander of the Naval T&E Command (NTEC) should be a Vice

Admiral who also serves as a Director, Major Staff Office (DMSO) within OPNAV with the title of Director, Naval Test and Evaluation. Figure 7 shows this proposed OPNAV structure. It should be noted that the dotted line relationship between the Chief of Naval Material and the Director, Naval T&E enables the Naval Material Command to assign DT&E and OT&E projects to the Naval T&E Command. Projects requiring Navy T&E from NAVAIR will be managed by the Chief of Naval Air T&E, and T&E projects from NAVSHIPS (Naval Ships Systems Command) will be managed by the Chief of Naval Ship T&E. Those T&E projects coming from the other systems commands of NAVMAT (Naval Electronic System Command, Naval Ordnance Systems Command, or Naval Facilities Engineering Command) or from NAVMAT designated Program Managers will be managed by either the Chief of Naval Air T&E or the Chief of Naval Ship T&E depending upon the nature of the project.

The proposed organizational change would put the Director, Naval Test and Evaluation (DNT&E) in a newly created Director, Major Staff Office billet (OP-09A) reporting directly to OP-09, the Vice Chief of Naval Operations (VCNO). For compliance with DOD Directive 5000.3, the Director, Naval T&E, would report the results of his Naval T&E Command's evaluations directly to CNO, the immediate superior of the VCNO. As a DMSO directly under OP-09, the Director, Naval T&E would be able to maintain the necessary degree of independence from the developing agency that



PROPOSED OPNAV STRUCTURE, INCLUDING A DIRECTOR, NAVAL TEST AND EVALUATION

FIGURE 7

should be required for the Commander of a T&E organization. He would never have to function both as the weapon system sponsor/proponent and as the T&E spokesman to the VCNO, as is now the case for OP-098. The data and judgments from each DMSO reporting to the VCNO would be evaluated as they are today. However added to the inputs from the other Major Staff Offices would be the Navy's unfiltered input from the independent T&E command. This added voice to the VCNO should facilitate the making of better system acquisition decisions at the VCNO/CNO level.

The creation of a DMSO for Naval T&E would not separate T&E from RDT&E. Development test and evaluation must be an integral part of the iterative research and development (R&D) process of design-test-evaluate-redesign that continues until technical uncertainties and development problems are resolved. This must, therefore, be the responsibility of the development contractor and the developing agency. The Director, RDT&E (OP-098) would remain the CNO focal point for this activity and for all R&D that is occurring within the Navy or under Navy's funding.

However, Navy conducted T&E would be organizationally separated from this process and would no longer be conducted by agencies working either for the program sponsor or the developing agency. This would place Navy conducted T&E in an ideal location, organizationally, independent from the developer and fully capable of reporting unbiased test results to the highest decision making level within the Navy.

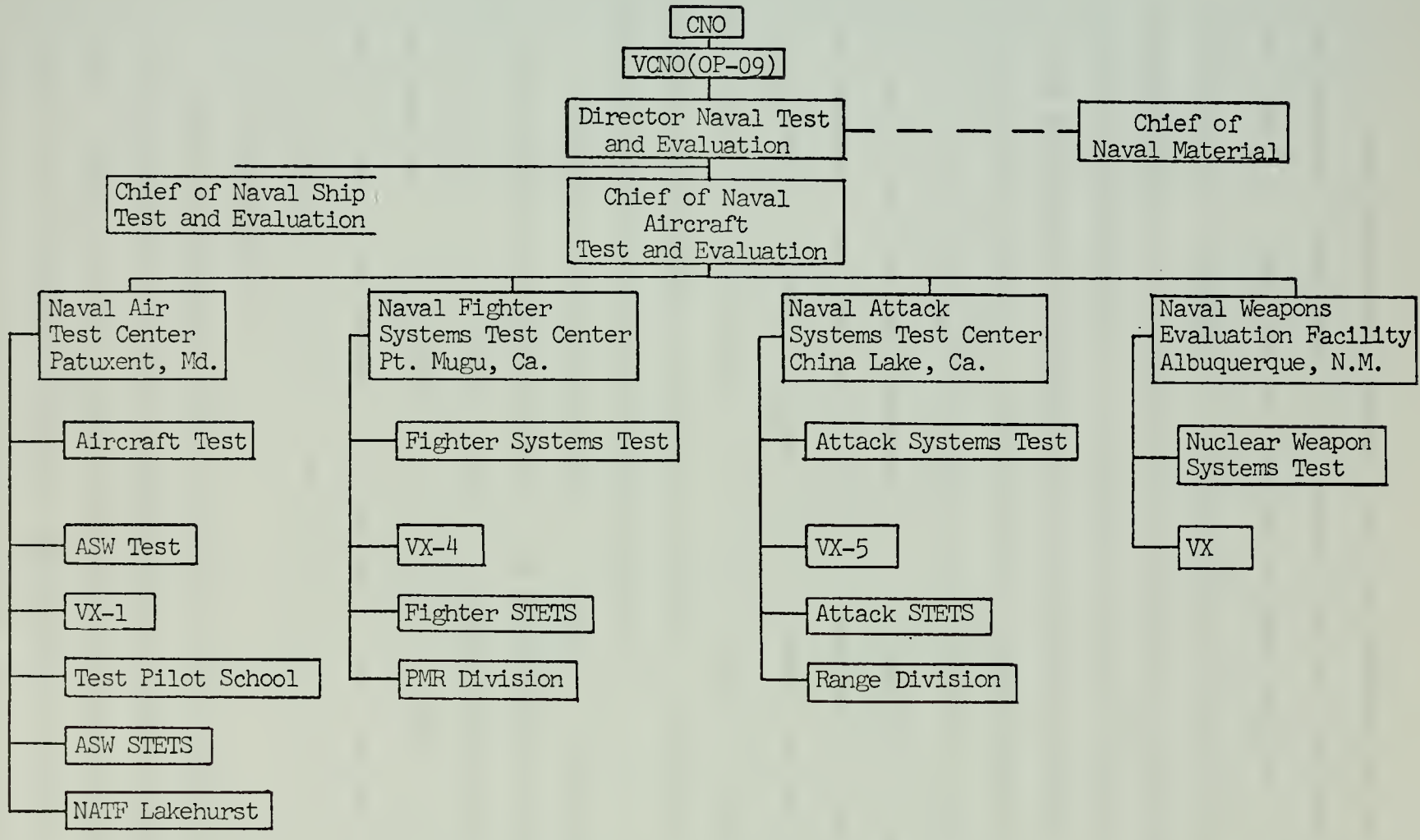
A. DESCRIPTION OF PROPOSED T&E COMMAND

The proposed Naval T&E Command (Fig. 8) would have two deputies reporting directly to the Director, Naval Test and Evaluation. One deputy, the Chief of Naval Aircraft Test and Evaluation would be responsible for all Navy T&E of aircraft and the associated weapons and ancillary equipment. The other deputy, the Chief of Naval Ship Test and Evaluation, would be responsible for all surface and subsurface ship T&E and the associated weapons and ancillary equipment. No discussion is contained in this thesis on the organization or responsibilities of the proposed Chief of Naval Ship Test and Evaluation. It is recommended that a separate study be conducted in this area to evaluate the feasibility of such an organization and to determine a suitable composition for such an organization.

The staff of the Chief of Naval Aircraft Test and Evaluation (CNAT&E) would be composed of personnel who would exclusively monitor and provide guidance for Range coordination, operational T&E by the VX squadrons, education of project personnel by either the Test Pilot School (TPS) or the System T&E Training Schools (STETS) to be created at each Test Center, and the typical staff functions of every major staff. The Commanders of the test centers and one test facility would report to the CNAT&E.

1. Naval Air Test Center, Patuxent River, Maryland

The Naval Air Test Center at Patuxent River would be responsible for the complete T&E of the aircraft vehicle



PROPOSED TEST AND EVALUATION COMMAND

FIGURE 8

(i.e. less the weapon system) and the associated auxiliary equipments. NATC would also become the air ASW test center, and would in addition perform T&E on most support aircraft. NATC would be composed of four test divisions and two training divisions. No consideration is given in this thesis to an instrumentation or technical services division which would probably be required at each major test center. The Aircraft Test Division would absorb the responsibilities of the current Flight Test and Service Test Divisions. Aircraft Test would be responsible for the flying qualities, performance, and carrier suitability testing of fixed and rotary wing aircraft (Flight Test's current responsibilities) and for the developmental T&E of propulsion and aircraft systems, excluding electrical, armament, and avionics (Service Test's current responsibilities).

The Naval Air Test Facility at Lakehurst, New Jersey would retain its responsibility for the T&E of catapults, arresting gear, and other aircraft launch and recovery equipments. Having NATF work directly for NATC would more easily facilitate better utilization of the catapult and arresting gear facilities that are located at both Patuxent River and Lakehurst.

The Anti-Submarine Warfare Systems Test (ASWST) Division would replace the current Weapons System Test Division at NATC. ASWST would be responsible for the developmental T&E of the electrical armament, and avionics systems in all rotary wing and fixed wing ASW aircraft and in support

aircraft, such as AEW (airborne early warning) aircraft and cargo aircraft. VX-1 would retain its present role of OT&E of ASW aircraft systems but would also become responsible for the OT&E of certain support aircraft. VX-1 would maintain its operational type organization and its close relationship with the operational forces.

The U.S. Naval Test Pilot School (TPS) would continue to report to the Commander, NATC, and its functions would remain unchanged. Approximately half of its Naval officer graduates would become project officers in the expanded Aircraft Test Division, and the remainder would be assigned to project officer billets primarily at the systems test divisions at the three test centers. While TPS would remain a relatively long duration school (one year) and would provide T&E training to all of the Aircraft Test Division's project officers and civilian engineers it would only provide training to a relatively small number of the project officers and civilian engineers throughout the rest of the Naval Aircraft T&E Command. Therefore, schools of relatively short duration, called System Test and Evaluation Training Schools (STETS), would be established at each test center to teach the fundamentals of T&E and provide a basic foundation in the technologies utilized in the necessary warfare specialities; i.e., ASW, air-to-air, attack, ECM, etc. (Appendix F presents the basic objectives of these schools). A STETS would be established at the Naval Air Test Center to teach the fundamentals of ASW and of any

required support warfare to the project officers and civilian engineers/analysts reporting to VX-1 and to the ASW Systems Test Division. Officers that just graduated from TPS might require a brief supplementary course from the STETS prior to commencing work in the systems test division, and those officers coming back for second tours of duty in T&E might require a special refresher STETS course.

2. Naval Fighter Test Center, Pt. Mugu, California

The Naval Missile Center Complex at Point Mugu would become the Naval Fighter Test Center and be responsible for the T&E of all air to air weapons systems and ancillary and support equipment. The Naval Fighter Test Center would be composed of basically four divisions: a Fighter Systems Test (FST) Division, VX-4, Fighter System T&E Training School (FSTETS), and PMR (Pacific Missile Range) Division.

FST would be responsible for the developmental T&E of fighter aircraft weapons, avionics, and electrical systems, and VX-4 would be responsible for the OT&E of the complete fighter aircraft system and/or air to air weapon system. The Fighter STETS would provide a relatively short course in T&E of fighter weapon systems to project officers and engineers/analysts reporting to FST and VX-4. It would function similar to the STETS at the Naval Air Test Center.

The PMR division would be responsible for the operation and management of the Pacific Missile Range.

3. Naval Attack System Test Center, China Lake, California

The China Lake complex (excluding the Naval Weapons Center[1]) would become known as the Naval Attack Systems Test Center (NASTC). It would be responsible for the T&E of all attack aircraft weapon systems, and all ECM systems and reconnaissance systems (excluding ASW). The center's responsibilities would include DT&E of the aircraft armament, avionics and electrical systems of all attack, ECM, and reconnaissance aircraft, the OT&E of these aircraft, and the complete Navy T&E of all air to surface weapons. The NASTC would be organized similar to the NFSTC at Pt. Mugu.

The four basic divisions of the NASTC would be Attack Systems Test (AST), VX-5, Attack STETS, and Range Division. The AST would be responsible for the developmental T&E of all attack aircraft weapon systems and weapons, and VX-5 would be responsible for the OT&E of the complete attack aircraft and/or air to surface weapon. The Attack STETS would provide the necessary attack, ECM, and reconnaissance systems T&E training for VX-5 and AST project officers and engineers/analysts. The Range division would be responsible for the operation and management of the various China Lake ranges.

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[1]The Naval Weapons Center (NWC) which is a Navy research and development laboratory located at China Lake would continue to report to the Chief of Naval Research and be the principal RDT&E Center for air warfare and missile systems. NWC would be able to task the NASTC to conduct DT&E and OT&E.

4. Naval Weapons Evaluation Facility (NWEF), Albuquerque, New Mexico

NWEF would retain its current function of T&E of nuclear weapons and the associated systems within the compatible delivery aircraft. NWEF would be subdivided into a technical division, Nuclear Weapons Systems Test, and an OT&E division, and a VX squadron. As a result of the relatively small size of NWEF a formal STETS would not be established. Instead its project officers and engineers/ analysts would receive T&E training at the Attack STETS at China Lake and the necessary nuclear technical training through an informal NWEF training course.

B. DT&E PERSPECTIVE

Discussion of the proposed reorganization with personnel in the Naval Air Systems Command was usually met with dissension. Their belief that the developing agency requires absolute control over all DT&E is unfounded. Most aircraft DT&E is conducted by the contractor, and it is only that portion of DT&E conducted by the Navy that is in dispute. Under the concept proposed in this thesis, the developing agency could task the Naval T&E Command to perform whatever type T&E is required. The funding for the T&E would be provided by the developing agency, and the Naval Air T&E Command would report its T&E results to the developer, exactly as is done today.

From the developer's perspective little change will have actually occurred other than the DT&E agencies would

no longer work directly for the developer. The Program Manager, the key man in managing the development and production of a weapon system, would operate in the NAVMAT Matrix organization in the same way as he does today. The PM would still task the various functional NAVAIR Divisions, other System Command Divisions, and civilian contractors to perform essential functions for his program. However, instead of tasking a NAVAIR agency to perform DT&E and OPTEVFOR to perform OT&E, he would task the Naval T&E Command to perform all of his Navy T&E.

The developing agency could task the Naval Air T&E Command to conduct only test and analysis rather than test and evaluation. This would permit the developing agency to merely task the T&E Command to obtain specific test data, but not to evaluate the significance of the data. This type of request from the developing agency might occur if the fleet were to lose one or more aircraft for an unexplained reason (e.g., the wing falling off in flight, but all incidents occurring over water and, therefore, no evidence exists which would point to the cause). In such a case NAVAIR would probably task the Naval Air T&E Command to perform numerous structural tests and analysis and merely send the various load data to NAVAIR for its evaluation, which would probably be done jointly with the particular airframe manufacturer.

At present, much of the development testing is planned by the Naval Air System Command, and very detailed

descriptions of the tests and test conditions are given to the DT&E agencies in the AIRTASKS, the official NAVAIR document which assigns work and provides funding to the DT&E agencies under NAVAIR's control. This same type procedure should work when NAVAIR tasks the T&E Command to perform development tests.

With Congressional pressure to decrease the military's Washington D.C. personnel, NAVAIR is facing severe cutbacks which could have an adverse effect on maintaining T&E expertise. The creation of a T&E Command would provide a simple means which would permit NAVAIR to decentralize this expertise. Many NAVAIR engineers could be transferred to the T&E Command which would accomplish two objectives:

(1) It would decrease the number of Navy personnel in Washington D.C.

(2) It would place the majority of the Navy's aircraft T&E expertise in the test agency.

In the current system much of the Navy's T&E expertise exists in NAVAIR, and consequently NAVAIR does much of the test evaluation, and the test centers do too little actual test evaluation.

Since the development agency is responsible for developing a system that works, meets specifications, and is operationally suitable, the timely and effective conduct of OT&E is as much a responsibility of the Program Manager as is the timely and effective conduct of DT&E. Under the proposed

T&E organizational concept, the development agency would be able to task the T&E command to perform OT&E in the same way as it would task the T&E Command to perform DT&E.

At present the Program Manager is essentially the NAVAIR decision point on where to conduct various tests for programs that are not tracked by DSARC. It is unlikely that each Program Office has sufficient T&E expertise to always make test location decisions which contribute to optimizing the utilization of the Navy's T&E resources. Program Manager's T&E decisions on where to conduct various tests are influenced unduly by the program's dollar and time constraints with too little regard for the expertise of the test agency.

In the current T&E structure, the developing agency's Program Manager has three alternatives when he requires that OT&E be performed:

(1) Task a DT&E agency to perform the tests and call the tests "testing for service suitability" vice OT&E

(2) Generate a request to CNO to have a Development Assist[1] project assigned to OPTEVFOR to conduct the desired OT&E

(3) Request that an operational unit (i.e. an aircraft squadron, ship, etc.) evaluate the item under operational conditions.

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[1]Development Assists are projects which are assigned by CNO at the request of the Developing Agency to OPTEVFOR [Ref. 26].

In the proposed T&E organization the Program Manager would no longer have the flexibility in deciding which organization should do Navy T&E. The Naval T&E Command would make that decision and be expected to optimize the utilization of the Navy's T&E resources while obtaining credible T&E results.

One criticism of the proposed change has been the size of the testing command that would be created and the many problems that are typical of large organizations. Care must be exercised to minimize creation of "paper work" stumbling blocks which are so easy to generate in large organizations. Prior to the establishment of a T&E Command, a study should be conducted to determine the best way to organize such a command while maintaining testing efficiency, especially in regard to timely completion of assigned T&E including publishing the reports.

One of the major problems facing Program Managers is obtaining T&E results within the time constraints specified in the tasking document (e.g., AIRTASK). As discussed in Section IV.B.6, the current T&E organization is frequently guilty of late completion of T&E reports. A fear voiced by Program Managers regarding the creation of a T&E command is the potential problem of its unwillingness to perform T&E in accordance with the Program Manager's time requirements with the Program Manager having no capability to order the T&E agency to perform as directed. Theoretically, this so

called "ordering" can be done now, but in practice this requires a dialogue between the Commander, Naval Air Systems Command and the Commander of the test agency. The decision as to whether to comply with the Program Manager's urgent T&E requirement will then consider the overall agency T&E workload and NAVAIR's overall requirements. In the proposed structure the Program Manager would hve to resort to different means to induce this same type of high level dialogue to determine the relative priority of his project. However, the central control of T&E should reduce the problem of determining relative project priorities, since random inputs from CNO to accomplish "his" special project would be much less likely, and these projects often cause arbitrary priorities.

An examination today of the responsiveness of OPTEVFOR and the timeliness of its completing T&E and publishing reports should dispel any doubts that an "independent" T&E agency would respond as rapidly for the developer as a T&E agency that works for the developer. OPTEVFOR does respond as rapidly and publishes its reports probably more promptly than the NAVAIR controlled DT&E agencies.

C. OT&E PERSPECTIVE

One of the big concerns of OPTEVFOR is the need to maintain a close identity with the operational community. There is a concern that if OT&E becomes too technical, it can no longer be truly operational. By adopting the

proposed T&E organizational change, the VX squadrons would be better able to maintain their valuable operational perspective, since they would not be compelled to develop an imbalance of technical expertise over operational expertise as appears to be happening today. Since the VX squadrons are being tasked to conduct some T&E solely on the basis of their "independence," rather than their expertise, OPTEVFOR is compelled to become more technically oriented in order to perform capably the increased technical T&E requirements. The danger of having this continue to the point that OPTEVFOR develops an overbalance on the technical aspects of T&E should be obvious.

The concept of having the VX squadrons operate very much like an operational squadron in order to maintain a better operational perspective would be retained. The VX squadrons would work closely with the co-located systems test division (ASW, fighter, or attack) throughout an aircraft's development. T&E reports from each of the test centers could contain solely the results of DT&E or OT&E or the reports could contain the results of combined testing (DT&E and OT&E). The combined T&E reports would have a technical section (for DT&E) and an operational section (for OT&E), and differing opinions in each section could occasionally be expected. However, the CNAT&E staff would comment on reports having significantly different findings in the technical and operational sections in order to aid DD(T&E),

DSARC, Program Manager, or other appropriate decision makers in reconciling the different opinions.

In the past the biggest contribution made by the VX squadrons was in the area of tactics development. This very important area cannot be overlooked, and the proposed organization would ensure that tactics development remains a major function of each VX squadron. By having the VX squadrons involved earlier in weapon system development they would be better prepared to develop sound tactics for each weapon system much sooner than in the past. (Previously it often took more than a year of fleet operation with a weapon system before a VX squadron released its report on optimum use procedures and employment tactics).

When personnel are involved in finding deficiencies and recommending changes to a weapon system throughout its development cycle, they very often develop strong feelings against certain features which they reported as being deficient, and which are often not corrected. It is important to have the people who are developing tactics for a weapon system fully believe in and be strong proponents of the potential of that weapon system. This is a potential problem area that exists in the current T&E process where the OT&E project officers are being put more into the role of developmental testing, in that they perform tests during the various iterations of design, and the specific deficiencies they cite assist in the evolution of the design.

This type of involvement has often caused a DT&E project officer to develop strong dissatisfactions toward the weapon system he tested.

The proposed T&E organization would not put the OT&E project officer into this design iteration testing process, but would allow him to view more readily the development of the entire system and not each subsystem design iteration. This will enable the OT&E project officer to maintain a better operational perspective of the entire system while becoming involved with the system early enough to develop tactics on a timely basis.

Perhaps the most overlooked, but often most valuable, portion of OT&E is the de facto OT&E that is conducted during the early deployments of a weapon system. As hard as the Navy tries to move OT&E earlier into the development cycle, it can never eliminate the value of the actual deployment of the weapon system in the operational environment. At present the operational command using the system is often confused as to whom he should report system problems. NAVAIR is naturally cognizant for aircraft systems but various T&E agencies often would be able to make a rapid and valuable contribution if they were informed of the problem. The user consequently informs NAVAIR but is usually uncertain as to whether to also contact OPTEVFOR, the appropriate VX squadron, NATC, NWC, NMC, or NWEF. The proposed organization would facilitate better retrieval of operational

data from the fleet by eliminating the operational command's dilemma in trying to determine which T&E agency is cognizant of each problem that arises.

D. T&E ORGANIZATIONAL CHANGE WILL CORRECT CURRENT T&E DEFICIENCIES

Many of the T&E deficiencies cited in Section IV of this thesis would be corrected by the adoption of the proposed T&E organizational change as follows:

1. Organizational Deficiencies

The creation of a DMSO for Naval T&E would ensure that proper high level attention is given to independent T&E results. Since the Director, Naval Test and Evaluation would not be assigned as a program sponsor, he would not be forced to change hats between the user and the producer (advocacy) roles as now occurs in OPNAV with OP-098.

Having the Director, Naval T&E report to OP-09 would preserve the test organization independence that is required by directive. This independence also appears logical and makes intuitive sense for a test organization. In many aircraft companies the Chief Test Pilot reports to the president as often does the Product Assurance Division.[1] The entire T&E command can be thought of as a

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[1]Product Assurance is the term now given to many companies' previous Quality Assurance Divisions, since Product Assurance is meant to be more encompassing. Product assurance includes the disciplines of design assurance, maintainability, reliability, test and evaluation, and safety.

Product Assurance group that ensures weapon systems meet specifications and are operationally suitable. Reporting of such an organization to a high level ensures unfiltered test results.

Duplication of T&E responsibilities would be more easily reduced if all Navy T&E is controlled within one Command. The T&E Command would install among the various DT&E agencies central line management control, which doesn't exist today in the NAVAIR T&E coordinator.

Since only one T&E Command would exist in the Navy, the flexibility of where to assign T&E projects would no longer rest with the Program Manager, but with the T&E Command. This would help ensure that adequate T&E is performed on non-major procurements.

The creation of a T&E Command which is entirely independent from the developing agencies would eliminate the dilemma facing DD(T&E) today. He would be able to place equal credibility on all test results from the T&E Command, and would not have to request an operational test agency to repeat a technical test merely to ensure that the required degree of independence is maintained in the test results.

Placing all T&E agencies under one command would facilitate the creation of a uniform system of funding throughout the testing community. It would also simplify the task of identifying all the funding required for T&E.

With all the test agencies under one command, all ranges would also be controlled by the same command. This central control of ranges would facilitate easier identification of effective and efficient range use and funding requirements.

2. Testing Deficiencies

Much of the overlap between OT&E and DT&E within the Navy has been caused by the need for independence being identified with only OT&E. By having all T&E independent of the developing agency the different perspectives of the OT&E and DT&E roles can be more easily retained.

Having T&E Command visibility at the VCNO level would ensure that test planning is given more attention and T&E experts become involved in this planning. This high level visibility should ensure the creation of better operational test objectives.

The problem of inadequate technical expertise in the OT&E test agency, OPTEVFOR, would be somewhat reduced as a result of the elimination of the need for the OT&E agency to expand its testing expertise into more developmental type testing. The creating of STETS (System T&E Training Schools) at each test center would provide a place to give all project officers and civilian engineers/analysts a basic background in T&E, and should therefore improve the entire OT&E and DT&E process.

Late test results is a problem that would not be corrected by the proposed organization alone. Since each

test center would be organized similarly, each test center would be motivated to develop the most efficient T&E report review process. However, this area should be given considerable attention when creating the Naval T&E Command.

With a T&E Command that is independent from the developer and that is capable of ensuring specification compliance, there would no longer be a need for BIS. It is, therefore, recommended that BIS be disestablished if this thesis proposal is adopted.

By having the VX squadrons within the T&E Command, the need for analysts throughout the T&E Command would become obvious. As the need for more analysts within the T&E community is recognized a better career pattern for analysts within Navy T&E should evolve. This would increase the ability of Navy T&E to attract and retain high caliber analysts.

By having one T&E Command it will be easier to ensure continual monitoring of development programs. The infrequent snap shot looks at a program by each of the Navy agencies which often occurs today was shown to be an unsatisfactory method for assessing system potential. The procedure of assigning a resident T&E team composed of both DT&E and OT&E personnel during a systems' early development is being utilized by the Air Force on the B-1 program [Ref. 27] and was utilized on the F-15 program. This procedure has considerable merit and will be relatively

easy to implement if all Navy T&E personnel were assigned to one Naval T&E Command.

The creation of a Naval T&E Command will give increased stature to all T&E within the Navy. This should make T&E duty for Naval Officers more highly desirable for second and third tours of duty than it is today. Effective military T&E can only be planned and accomplished by personnel who have operational and technical backgrounds and testing experience. Too little emphasis in the past has been placed upon encouraging good officers to become specialized in the T&E field and to develop that necessary testing experience. As a result, many middle and top managers within the T&E agencies are not of the caliber necessary to manage the type of effective and efficient T&E that the Navy's limited resources demand. The creation of a Naval T&E Command will hopefully do much to eliminate this deficiency.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

1. The valuable internal "user-producer dialogue" is lost during the latter stages of a weapon system's development, since the Navy's independent T&E organization, OPTEVFOR, reports to OP-098 who is compelled to act as a system proponent and must often conceal weapon system development problems.

2. Neither the development T&E agencies nor OPTEVFOR is independent from the influence of the developing agency.

3. An excessive amount of duplication exists in the testing conducted by the major participants in the Navy aircraft weapon system T&E process.

4. Inadequate central management exists among the NAVAIR T&E activities, consequently costly duplication of facilities and expertise exists among the NAVAIR T&E activities.

5. OPTEVFOR is being tasked to perform T&E often on the basis of its independence rather than on its testing capability.

6. Adequate checks do not exist in the Navy's acquisition process for non-major systems to ensure that adequate T&E is conducted and that the major deficiencies are corrected prior to procuring and deploying the system.

7. The costs for conducting T&E cannot be totally identified, and numerous methods are utilized by the T&E

agencies to calculate the costs of their performing T&E. This lack of standard cost accounting makes T&E cost-effectiveness decisions nearly impossible to perform.

8. Central aircraft T&E range management does not exist, consequently it is a difficult task to justify the various ranges and make rational decisions when forced to reduce range assets.

9. A clear distinction between the responsibilities of DT&E and OT&E does not exist, consequently testing duplication is increasing.

10. Test agencies do not participate adequately in early T&E planning.

11. Adequate criteria against which OT&E can be conducted often does not exist.

12. Inadequate technical expertise exists in OPTEVFOR to effectively perform all of its responsibilities. This problem has been magnified by the increased T&E responsibility given to OPTEVFOR.

13. A definite requirement exists for a technical course of instruction in the discipline of Weapon System T&E.

14. Program Managers frequently do not receive test results from the various test agencies soon enough to assist in making vital program decisions.

15. OPNAVINST 3960.8 shows BIS commencing along with OPEVAL prior to the DSARC III major production decision. This sequencing is illogical if BIS and OPEVAL are to retain their current roles.

16. A shortage of statistical analysts exists throughout the T&E community (DT&E and OT&E).

17. Test and evaluation is often treated as a process where snapshot looks at a system can give valid conclusions as to the system's development progress. This is false, and T&E must be treated as a continuing process.

18. Many good characteristics continue to exist in the Navy's T&E process.

a) Navy test pilots and NFO's typically have and maintain excellent operational backgrounds
b) Testing is conducted by relatively small organizations
c) Competition among test agencies stimulates good performance
d) Decentralized test management is practiced
e) T&E attracts top caliber military personnel

B. RECOMMENDATIONS

1. The Navy should create a Naval T&E Command that would have responsibility for all Navy conducted T&E and OT&E with the exception of the necessary T&E conducted by Navy laboratories in fulfilling their R&D missions.

2. The Commander of the Naval T&E Command should also serve as a Director, Major Staff Office reporting to OP-09, the VCNO.

3. The Naval Air T&E Command should be organized as proposed in this thesis.

4. A study should be conducted to determine the appropriate organizational structure and functions of a Naval Ship T&E Command.

5. A System T&E Training School should be established at each of the major test centers.

APPENDIX A

ORGANIZATIONS WITH WHICH INTERVIEWS WERE CONDUCTED

1. Office of the Secretary of Defense, Washington, D.C.

   DDR&E (T&E)

2. Office of the Secretary of the Navy, Washington, D.C.

   ASN (R&D)

3. Office of the Chief of Naval Operations, Washington, D.C.

   OP-983
   OP-506
   OP-508

4. Naval Air Systems Command, Washington, D.C.

   AIR 05
   AIR 510
   PMA-241
   PMA-244
   NAVAIR T&E Coordinator, Patuxent River, Md.

5. Senate Armed Services Committee

   RDT&E Subcommittee

6. Naval Air Test Center, Patuxent River, Md.

7. Sub Board of Inspection and Survey, Patuxent River, Md.

8. Operational Test and Evaluation Force

   Headquarters, Norfolk, Va.
   Air Development Squadrons One, Four and Five
   Deputy COMOPTEVFOR, North Island, Ca.

APPENDIX B

DEFINITIONS OF DEVELOPMENT AND OPERATIONAL TEST AND EVALUATION

Development Test and Evaluation (DT&E)

DT&E is that T&E conducted under the sponsorship of the developing agency to facilitate in the evolution of the system. Its specific functions are to:

"(1) demonstrate that the engineering design and development process is complete.

(2) demonstrate that the design risks have been minimized.

(3) demonstrate that the system will meet specifications.

(4) estimate the system's military utility when introduced." [Ref. 6]

The types of tests included in DT&E are: engineering tests, contractor/laboratory demonstrations, Navy Technical Evaluations (NTE), Navy Preliminary Evaluations (NPE), and deficiency correction tests. Advanced development, engineering and production prototype models are used for DT&E.

Operational Test and Evaluation (OT&E)

> "OT&E is that test and evaluation conducted to estimate the prospective system's military utility, operational effectiveness, and operational suitability (including compatibility, interoperability, reliability, maintainability, and logistic and training requirements), and need for any modifications. In addition, OT&E provides information on organization, personnel requirements, doctrine, and tactics . . . OT&E will be accomplished by operational and support personnel of the type and qualifications of those expected to use and maintain the system when deployed, and will be conducted in as realistic an operational environment as possible." [Ref. 6]

OT&E is divided into two categories, initial operational test and evaluation (IOT&E) and follow-on operational test and evaluation (FOT&E). IOT&E is that OT&E conducted prior to the first major production decision (DSARC III). FOT&E is the continuing OT&E of a weapon system after the production decision has been made.

APPENDIX C

INSTRUCTIONS/DIRECTIVES PERTAINING TO THE T&E OF NAVAL AIRCRAFT WEAPON SYSTEMS

DOD Directive 5000.1, "Acquisition of Major Defense Systems", 13 July 1971

DOD Directive 5000.3, "Test and Evaluation", 19 July 1973

SECNAV Instruction 5000.1, "System Acquisition in the Department of the Navy", 13 March 1972

OPNAV Instruction 3930.8B "Assignment and Prosecution of Test and Evaluation Projects", 5 April 1973

OPNAV Instruction 3960.8 "Test and Evaluation of Navy Systems and Equipments", 22 January 1973

OPNAV Instruction 5420.70, "Mission, Organization and Function of the Board of Inspection and Survey", 2 April 1971

OPNAV Instruction 5440.47D, "Mission and Functions of Operational Test and Evaluation Force (OPTEVFOR)", 6 March 1973

NAVAIR Instruction 5400.27B, "Assignment of Coordination Responsibilities for the Naval Air Systems Command's Test and Evaluation Functions", 20 December 1972

INSURV Instruction 13100.1A, "Aircraft Acceptance Trials; Procedures For", 1 October 1972

APPENDIX D

NAVAL AIRCRAFT WEAPON SYSTEM T&E ORGANIZATIONS

Naval Air Systems Command

Naval Aerospace Recovery Facility, El Centro, Calif.
Develop, test, and evaluate parachutes and related systems for human escape methods and systems, and retardation and recovery systems.

Naval Air Engineering Center, Philadelphia, Pa.
RDT&E in launching, recovery, and landing aids for aircraft and in ground support equipment for aircraft and airborne weapons systems.

Naval Air Propulsion Test Center, Trenton, N.J.
Test and evaluate aircraft propulsion systems -- their components, accessories, fuels, and lubricants.

Naval Air Test Center, Patuxent River, Md.
Test and evaluation of aircraft weapons systems, their components and related equipment.

Naval Missile Center, Pt. Mugu, Calif.
Test, evaluation and development support of Naval weapons, weapons systems and related devices.

Naval Weapons Evaluation Facility, Alburquerque, N.M.
Test and evaluation and technical support for nuclear and designated non nuclear weapons and weapon systems.

Operational Test and Evaluation Force

VX-1 (Air Test and Evaluation Squadron One), Patuxent River, Md.
OT&E of airborne anti-submarine weapon systems, support systems, components, and equipment.

VX-4, Point Mugu, Calif.
OT&E of all-weather fighter weapons systems and air-launched guided missiles weapon systems.

VX-5, China Lake, Calif.
OT&E of airborne attack weapon systems and support systems.

Chief of Naval Research

Naval Air Development Center, Warminster, Pa.
Principal Navy Research, Development, T&E center for Naval Aircraft systems.

Naval Weapons Center, China Lake, California
Principal Navy RDT&E center for air warfare and missile systems.

APPENDIX E

NAVY RANGES AND FACILITIES USED FOR AIRCRAFT WEAPON SYSTEM T&E

Ranges:

Atlantic Fleet Weapons Range, Roosevelt Roads, Puerto Rico

Atlantic Undersea T&E Center (AUTEC), West Palm Beach, Fla.

Pacific Missile Range (PMR), Pt. Mugu, Ca.

Naval Weapons Center (NWC) Ranges, China Lake, Ca.

Naval Weapons Laboratory (NWL) Ranges, Dahlgren, Va.

Facilities with their associated test cites:

Naval Aerospace Recovery Facility, El Centro, Ca.

Naval Air Propulsion Test Center, Trenton, N.J.

Naval Air Test Center (NATC), Patuxent River, Md.

Naval Air Test Facility (NATF), Lakehurst, N.J.

Naval Explosive Ordnance Disposal Facility, Indian Head, Md.

Naval Ordnance Missile Test Facility, White Sands, N.M.

Naval Weapons Evaluation Facility (NWEF), Albuquerque, N.M.

APPENDIX F

SYSTEM TEST AND EVALUATION TRAINING SCHOOLS (STETS)

The main purpose of the STETS would be to teach the basic fundamentals of T&E to project officers and civilian engineers/analysts who are engaged in aircraft weapon system T&E. Specifically, each major test center would have a STETS which would provide courses of study for all project officers and civilian engineers/analysts who are being assigned to T&E jobs. Each test center's STETS would concentrate on teaching the fundamentals of the particular warfare specialties of that test center (e.g. STETS China Lake would concentrate in the areas of aircraft attack systems, air to ground weapons, electronic countermeasures, and reconnaissance).

In addition to teaching the technical and statistical aspects of T&E, STETS would also conduct classes dealing with the following: the test center's range/s utilization procedures and capabilities, the Navy's organization for weapon system acquisition and the role that the test center fulfills, the test center's funding system and the procedures that must be followed to enable it to function, technical services (instrumentation, photo coverage, computer time, etc.) that are available to the test team and how to obtain those services, and technical report writing.

The STETS full course of study would take approximately eight to ten weeks with half day attendance. The half day attendance would enable the pilots and NFO's to spend the other halves of these days in familiarizing themselves with the aircraft/new systems they would eventually be testing, in further developing their flying proficiency, and in commencing an orderly project takeover from the project officer they would be replacing. The civilian engineers/ analysts would spend the other halves of these days working in their respective divisions by providing assistance to the experienced engineers in data reduction or in some other tasks which they could fulfill.

Besides the STETS full course of study, abbreviated courses should be offered. These abbreviated curriculums would serve as refresher courses for officers who are reassigned to T&E billets and have already graduated from the full STETS course. The abbreviated curriculum could also be used to give TPS graduates that are being assigned to non-aircraft division billets a better foundation in Weapon System testing.

The following is a typical course content which could be utilized by the STETS.

1. Mathematics/Mechanics refresher - introductory course including analytical geometry, calculus, statics, and dynamics. Its main purpose would be to ensure all students have a reasonable foundation in these essential engineering fundamentals.

2. Statistics - a course to give the student sufficient depth of understanding in probability and statistics that he would be able to appreciate the statistical implications of test design and test results. Course would present some simple statistical test designs and illustrate the increased test effectiveness and potential cost savings that are possible when tests are designed knowledgeably.

3. Computer Technology - an introductory course where digital and analog systems are studied. Fundamentals would be studied and student would be taught how to utilize various computer systems available at the test center. The integration of computers into complex weapon systems would be studied as would methods of differentiating computer software problems from system hardware problems in complex weapon system testing.

4. Fundamentals in Warfare Specialty (more than one of these might be offered at each STETS) - course would teach the basic fundamentals of the particular warfare specialty. General areas to be studied include: test techniques, system integration problems, state of the art limitations, new technological advances and their potential applications, etc.

5. Data acquisiton - course would study different types of instrumentation and photo equipment systems. Capabilities, limitations, and relative expenses of each would be studied. Each student would learn how to read different

types of instrumentation and become familiar with the typical errors that may result.

6. Weapon System Acquisition Process - this course would present a general overview of the entire acquisition process highlighting how the particular test center fits into the process. Requirements determination, DSARC process, DOD PPBS process, DOD agency roles and responsibilities, DOD budget cycle, program manager's role, etc. would be studied.

7. Range Operation - operation and capabilities of the test center's ranges would be studied as would the capabilities available at other Navy and DOD ranges. The particular operating procedures for the test center's ranges would be studied.

8. Test Center Support - the myriad of support facilities at the test center would be studied as would the procedures required to obtain these services. These include instrumentation, photo coverage, computer services, aircraft maintenance, etc.

9. Project Funding - the operation of the test center's budget system would be studied as would the procedures required to obtain funding for a particular project. The test center's budget system reporting requirements would be taught.

10. Report Writing - this course would teach technical report writing in accordance with the test center's procedures.

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This thesis evaluates the Navy's test and evaluation (T&E) process for aircraft weapon systems, identifies problems, and proposes a reorganization of the Navy's T&E agencies. Many changes have been made to improve the T&E process, but some of these have resulted in costly inefficiencies. Contributing problems include: the Navy's "independent" test agency being tasked more on the basis of its apparent independence than on

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(20. ABSTRACT continued)

its testing expertise, lack of actual independence of the many test agencies, excessive testing duplication, inadequate test planning, lack of a weapon system T&E school, and numerous T&E management problems.

The establishment of a Naval T&E Command which is organizationally separate from the developing agency and the OPNAV program sponsor is proposed. The Naval T&E Command would be responsible for all T&E conducted by the Navy with the exception of that done by Navy Laboratories. The Naval T&E Command would have separate divisions responsible for development T&E and operational T&E, and the developing agency could task the T&E Command to perform any type of T&E.